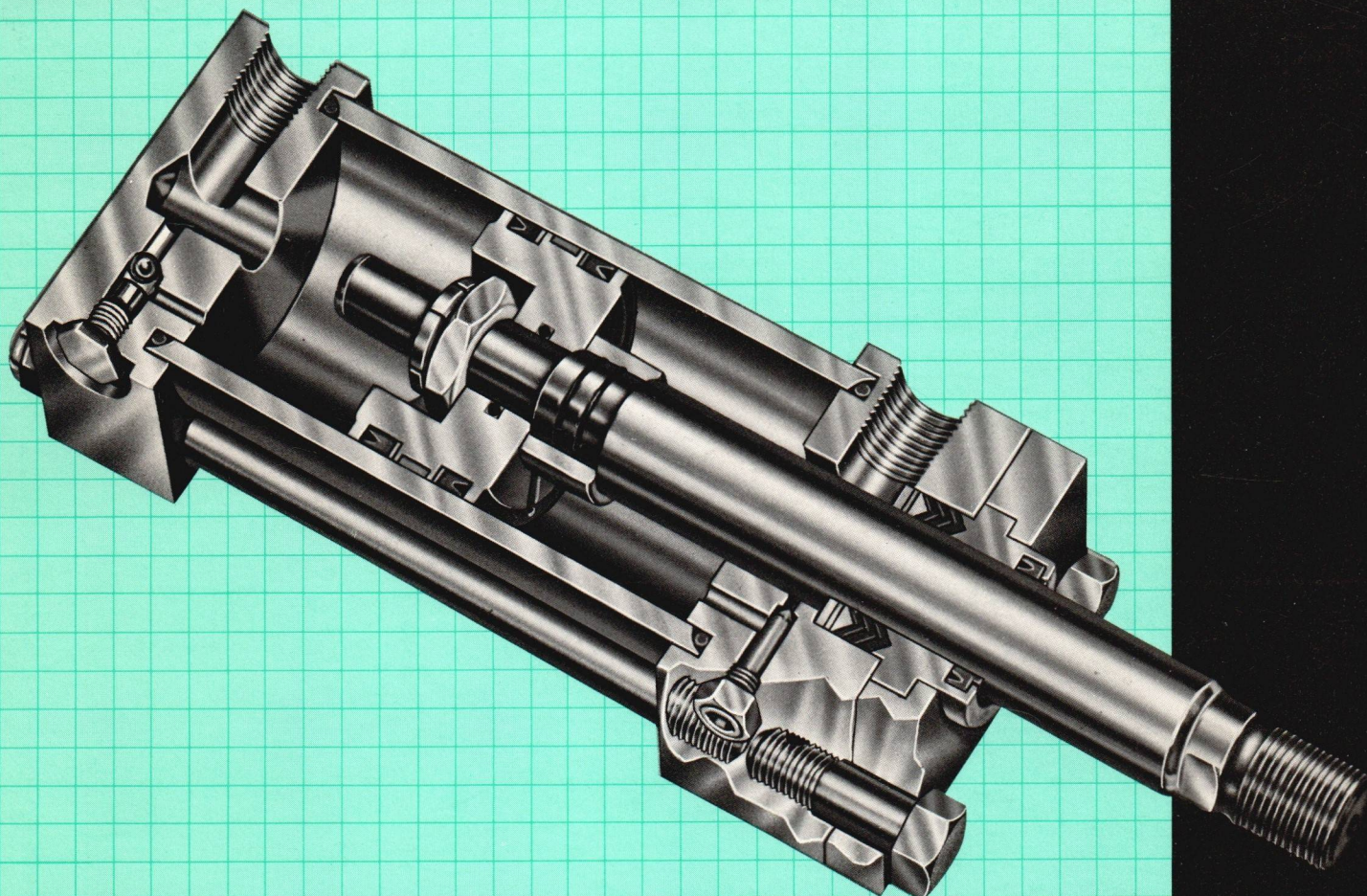


**milwaukee**  
*Cylinder*  
a **versa tek** company

# **SERIES LH**

1½" thru 6" Bore  
750 to 1500 PSI



# **LOW PRESSURE HYDRAULIC CYLINDERS**

*with Removable Retainers*



National  
**FLUID  
POWER**  
Association  
MEMBER



# How to use this catalog . . .

Before selecting a cylinder, take a few moments to read through this catalog. Pay particular attention to the pages concerning design options and rod size selection.

A Complete Index is shown below. Page 3 offers a Quick Index. The Complete Index is divided into sections according to subject with a brief description and the associated page number. The Quick Index illustrates the standard available mountings with the number of the page containing dimensional data.

## Complete index

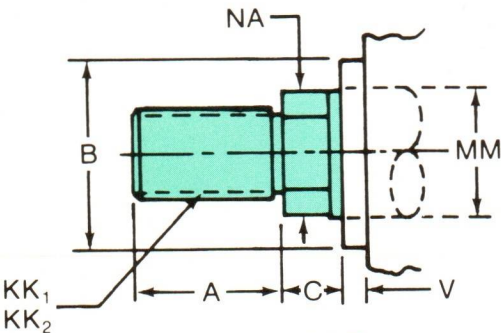
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PISTON ROD  
END STYLES

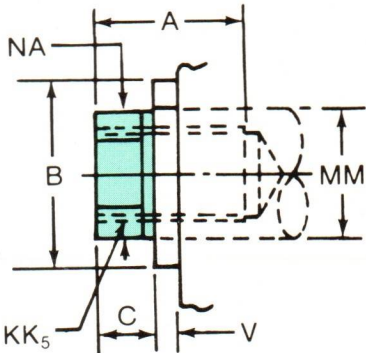
Piston rod end dimensional data

TABLE 3    Piston rod end styles

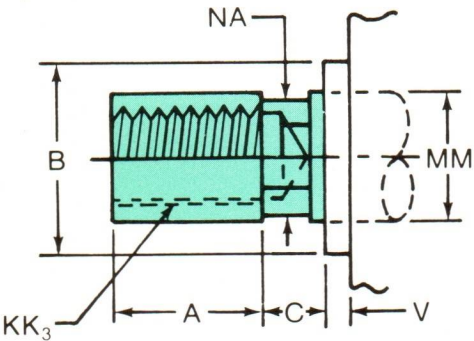
**Caution —**  
When ordering replacement cylinders for competitive brands our Style No. 1 Rod Ends may not be interchangeable with other cylinder manufacturers Style No. 1. Our Style No. 2 should be used if this applies to your application.



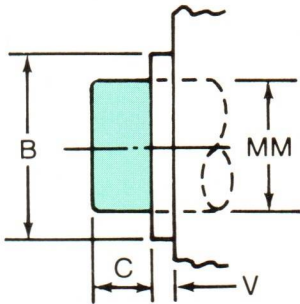
ROD END STYLE  
CODE NO. 1 (KK<sub>1</sub>)  
CODE NO. 2 (KK<sub>2</sub>)



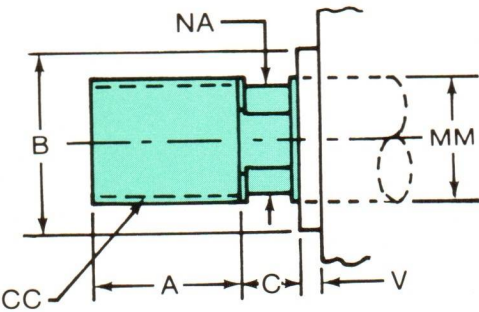
ROD END STYLE  
CODE NO. 5



ROD END STYLE  
CODE NO. 3



ROD END STYLE  
CODE NO. 6



ROD END STYLE  
CODE NO. 4

ROD MM	A	B -.001 -.003	C	CC	*D	KK -1-	KK 2-3-5	NA
5/8	3/4	1 1/8	3/8	5/8-18	1/2	1/2-20	7/16-20	19/32
1	1 1/8	1 1/2	1/2	1-14	7/8	7/8-14	3/4-16	31/32
1 3/8	1 5/8	2	5/8	1 3/8-12	1 1/8	1 1/4-12	1-14	1 11/32
1 3/4	2	2 3/8	3/4	1 3/4-12	1 1/2	1 1/2-12	1 1/4-12	1 45/64
2	2 1/4	2 5/8	7/8	2-12	1 11/16	1 3/4-12	1 1/2-12	1 61/64
2 1/2	3	3 3/8	1	2 1/2-12	2 1/16	2 1/4-12	1 5/8-12	2 29/64
3	3 1/2	3 3/4	1	3-12	2 5/8	2 3/4-12	2 1/4-12	2 15/16
3 1/2	3 1/2	4 1/4	1	3 1/2-12	3	3 1/4-12	2 1/2-12	3 3/16
4	4	4 3/4	1	4-12	3 3/8	3 3/4-12	3-12	3 15/16

\*Distance Across Wrench Flats



# When your requirements call for . . .

- proven performance
- expert workmanship
- advanced engineering
- quality materials



## ask for Milwaukee . . .

We're proud of our role as a supplier of NFPA Industrial Cylinders to a good selection of some of the outstanding manufacturers in our country. When the cylinder they are buying must have built in performance qualifications they not only turn to us, but keep coming back for more. We've supplied cylinders for use in agriculture irrigation, for food processing equipment, machinery used in automotive and truck manufacturing.

We also supply cylinders for the machine tool industry, testing equipment, and materials handling. At Milwaukee our standard line of cylinders offer an extensive variety for most jobs. If a standard won't fit your bill we're specialists in engineering entirely different cylinders to perform the functions you require. Remember if you take as much pride in your product as we take in ours, we'd like to work with you.

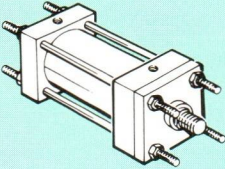
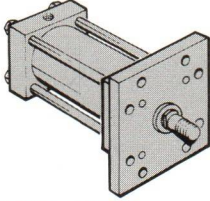
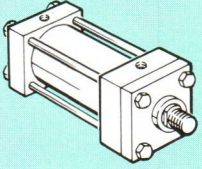
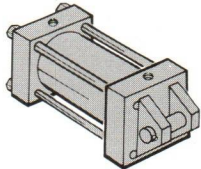
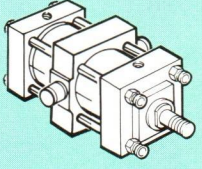
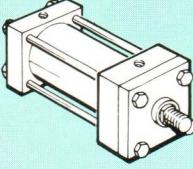
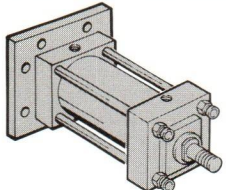
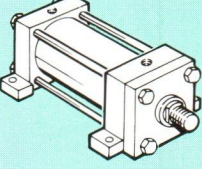
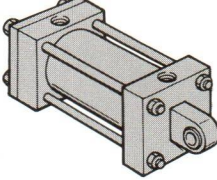
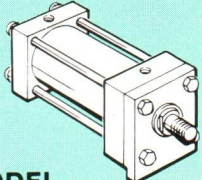
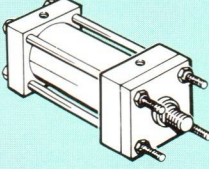
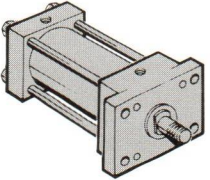
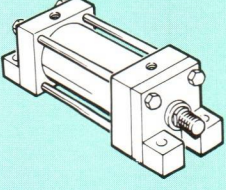
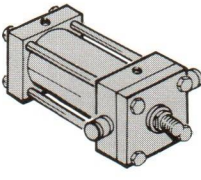
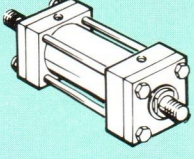
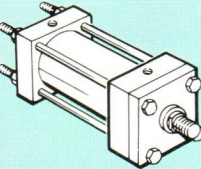
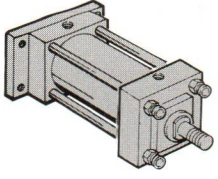
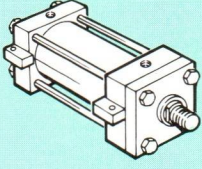
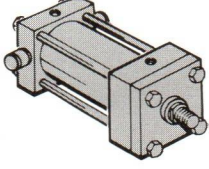
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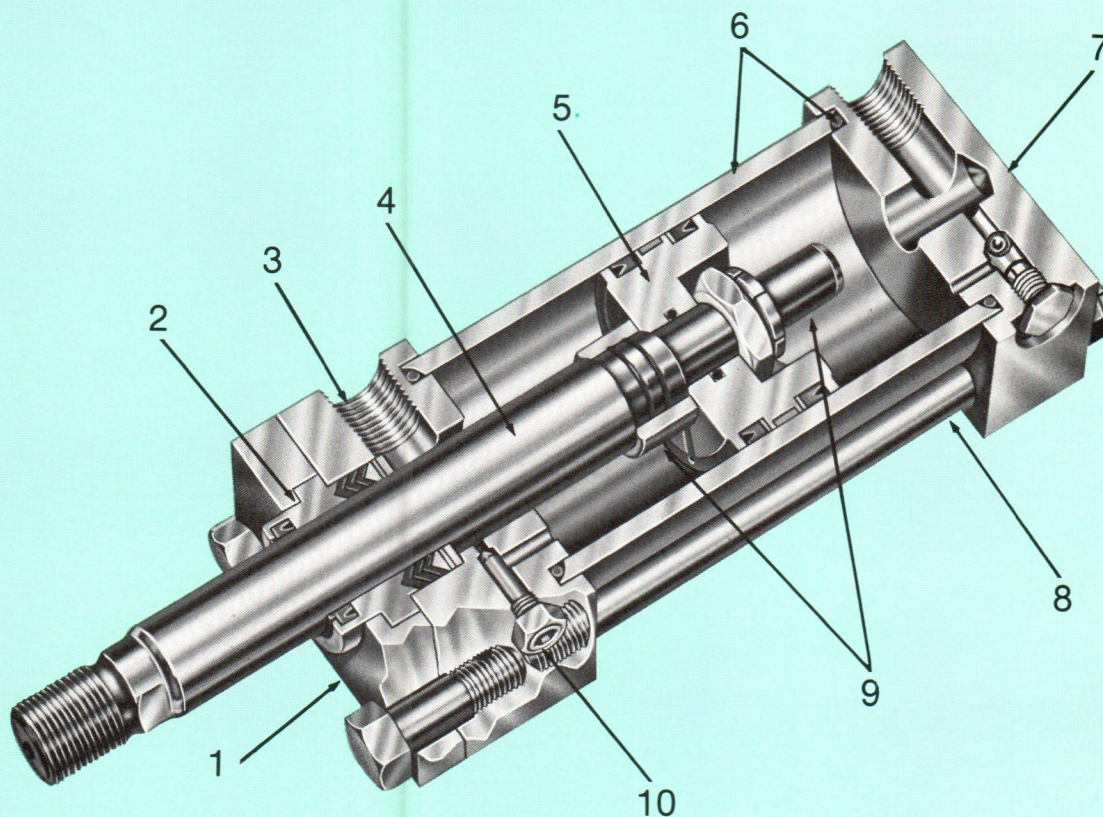
# Quick index

MILWAUKEE Series "LH" low pressure hydraulic cylinders are built to perform on the toughest applications. Incorporating a variety of MILWAUKEE "Exclusive" advanced features, proven through the years, these cylinders will provide a long maintenance free service life. Advanced engineering combined with quality materials and expert workmanship contribute to the making of a rugged top quality hydraulic cylinder.

				
<b>MODEL LH10</b> NFPA MX1 PAGE 6	<b>MODEL LH21</b> NFPA MF5 PAGE 8	<b>MODEL LH41</b> NFPA MS4 PAGE 10	<b>MODEL LH61</b> NFPA MP1 PAGE 12	<b>MODEL LH73</b> NFPA MT4 PAGE 12
				
<b>MODEL LH11</b> NFPA MX PAGE 6	<b>MODEL LH22</b> NFPA MF6 PAGE 8	<b>MODEL LH42</b> NFPA MS2 PAGE 10	<b>MODEL LH62</b> PAGE 12	<b>MODEL —</b> <b>KEY MOUNT</b> PAGE 20
				
<b>MODEL LH12</b> NFPA MX3 PAGE 6	<b>MODEL LH31</b> NFPA MF1 PAGE 8	<b>MODEL LH43</b> NFPA MS7 PAGE 10	<b>MODEL LH71</b> NFPA MT1 PAGE 12	<b>DOUBLE ROD END</b> <b>NFPA MDX</b> PAGE 20
				
<b>MODEL LH13</b> NFPA MX2 PAGE 6	<b>MODEL LH32</b> NFPA MF2 PAGE 8	<b>MODEL LH51</b> NFPA MT3 PAGE 10	<b>MODEL LH72</b> NFPA MT2 PAGE 12	



# Standard specifications and features



## Standard Features

- **STANDARD CONSTRUCTION—**  
SQUARE HEAD-TIE ROD DESIGN
- **NOMINAL PRESSURE—750 PSI**  
TO 1500 PSI (REF. PG. 17, TABLE 8)
- **STANDARD FLUID-HYDRAULIC OIL**
- **STANDARD TEMPERATURE—**  
-20 F TO +250 F
- **STANDARD BORE SIZES—**  
1-1/2" THRU 6"
- **STANDARD PISTON ROD DIAMETERS—**  
5/8" THRU 4"
- **STANDARD MOUNTING STYLES—**  
EIGHTEEN STANDARD STYLES PLUS  
CUSTOM DESIGNS TO SUIT YOUR NEEDS
- **STROKES—AVAILABLE IN ANY STROKE**  
LENGTH UP TO 240"
- **CUSHIONS—AVAILABLE AT EITHER OR**  
BOTH ENDS OF STROKE
- **STANDARD SIX ROD END STYLES PLUS**  
SPECIALS DESIGNED TO ORDER

### 1. Removable Retainer Plate

The retainer plate and rod bushing are externally removable. On most models total disassembly of the cylinder is not necessary. Four self locking capscrews hold the retainer plate in place.

### 2. Rod Bushing and Seals

A combination of spring loaded multiple lip vee rings with a supporting bronze bushing is standard in Milwaukee Series "LH" cylinders.

### 3. Ports

Large NPTF cylinder ports are provided. They can be rotated to any 90 degree position in relation to each other and the mounting.

### 4. Piston Rod

The piston rod is of high strength steel. It is hardened and plated to resist scoring and corrosion to assure maximum seal life.

### 5. Piston

The Series "LH" piston is precision machined from high strength aluminum alloy. It is pilot fitted and locked to the piston rod with a self locking nut that is staked.

### 6. Cylinder Barrel

The barrel is of steel tubing honed to a fine finish to assure superior sealing, minimum friction and maximum seal life. It is step cut on the I.D. of both ends for O-ring seals.

### 7. End Caps

The end caps and mountings are of high quality steel precision machined for accurate mounting.

### 8. Tie Rods

The tie rods are constructed from a high quality medium carbon steel. The threads are accurately machined for rigid engagement of the nuts.

### 9. Cushions

The cushions are machined to close tolerance to provide positive, smooth deceleration at the end of stroke.

### 10. Cushion Needle Adjustment and Ball Check

The cushion adjustment valve and cushion check ball retainer screw are specially designed to provide full cushion adjustment and sealed with a teflon ring to prevent leakage.



# Performance tested design features



## Simple Maintenance . . .

Simple maintenance is a reality with a "Milwaukee" cylinder. The rod bushing or rod seals can be inspected or serviced by merely removing the Nylok Cap Screws and retainer plate on most models. Standard available shop tools can be used to remove the rod bushing and seals without disturbing the torque on the tie rods assuring performance quality with maintenance ease.

optional, one-piece  
bushing and  
rod seal

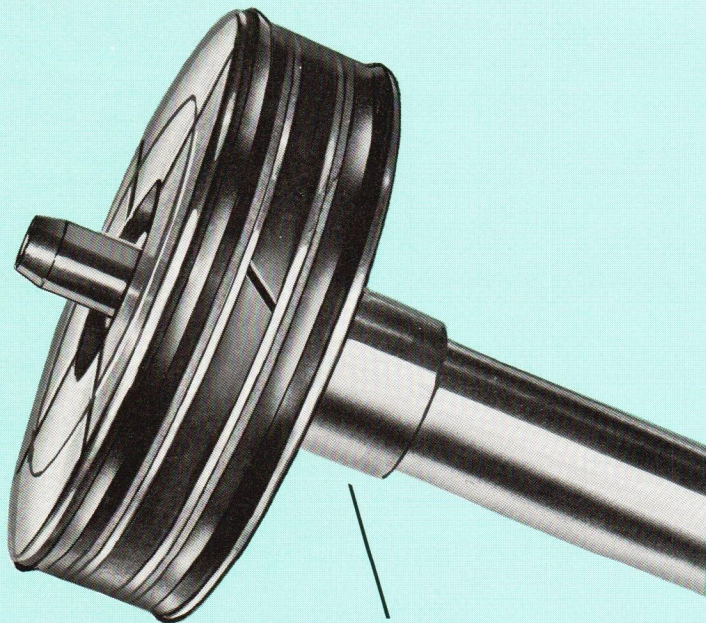


## Combination Rod Seal Design . . .

The Milwaukee Series "LH" cylinder combines spring loaded multiple lip vee rings with a supporting bronze bearing ring bushing and a double lip wiper as a secondary seal. This proven rod seal design combination is effective at both high and low pressures. It affords in addition to maximum sealing, an extra long bearing support.

As an optional design, a one-piece rod bushing with a single lip block vee seal and a double lip wiper is available. Metallic rod scrapers may be supplied on request, in place of the double lip wiper with either rod bushing design.

The unique versatility of the Milwaukee Series "LH" design makes available a selection of seals to meet all types of service conditions.



## Piston and Seal Combination . . .

The Milwaukee Series "LH" cylinder combines a non-scoring wear ring, with two block vee seals and a high strength aluminum alloy piston. This proven design combines low friction and smooth break away with the near zero leakage of the block vee seal.

## CUSHIONS . . .

The cushion is of a high grade alloy, precision machined and specially tapered to provide smooth deceleration of the piston at the end of stroke. The rod end cushion bushing is floated on two O-rings to compensate for minor misalignments during normal operation. This is to assure that our customers receive the total quality of performance that is designed into a Milwaukee Cylinder.

## PISTON ROD . . .

The piston rod is hardened, plated high strength steel, machined and processed to resist scoring and corrosion assuring maximum life. Milwaukee offers six rod end styles as standard. The style #1 rod end with two wrench flats is furnished as standard unless the customer specifies another style. Special rod ends and extra wrench flats are available at a slightly extra charge. They must be specified at the time of order giving the dimensional requirements and the location of additional wrench flats.



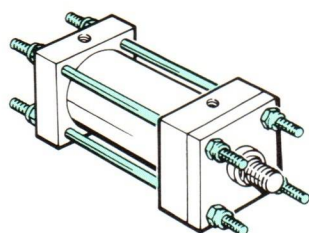
# TIE-ROD MOUNT

The flange and tie-rod mounts are basically the same except that the cylinder tie rods are extended and used to mount the cylinder. To prevent misalignment, sagging, or possible binding of the cylinder, when long strokes are required, the free end should be supported. The best use of tie-rods when extended on the

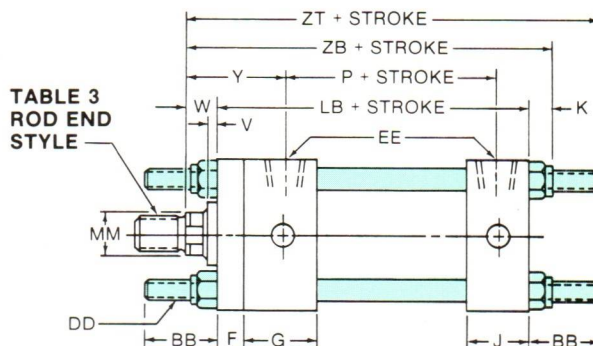
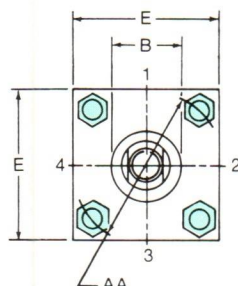
blind end is in a thrust load application. When using tie-rods extended on the rod end, the best application is a tension load. Tie rod mounts are suited for many applications, but it should be noted that they are not as rigid as the flange type of mounting.

FOR PACKAGE AND MOUNTING DIMENSIONS SEE TABLES 1 AND 2

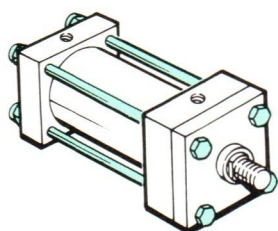
## TIE-RODS EXTENDED BOTH ENDS



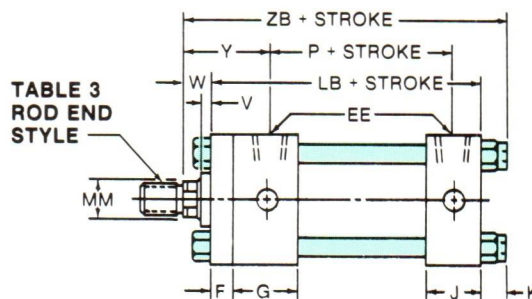
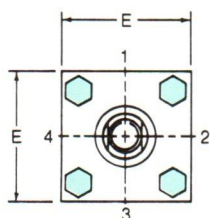
**MODEL LH10  
NFPA STYLE MX1**



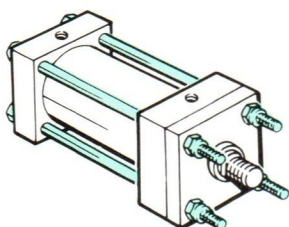
## NO TIE-ROD EXTENSION



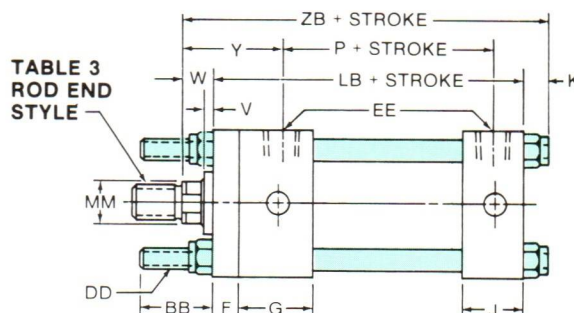
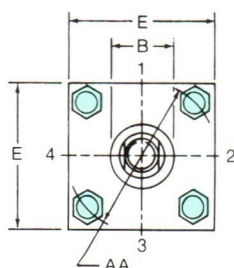
**MODEL LH11  
NFPA STYLE MX**



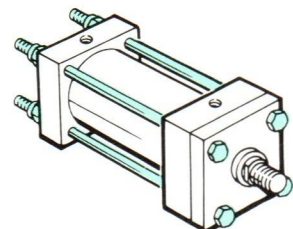
## TIE-RODS EXTENDED ROD END



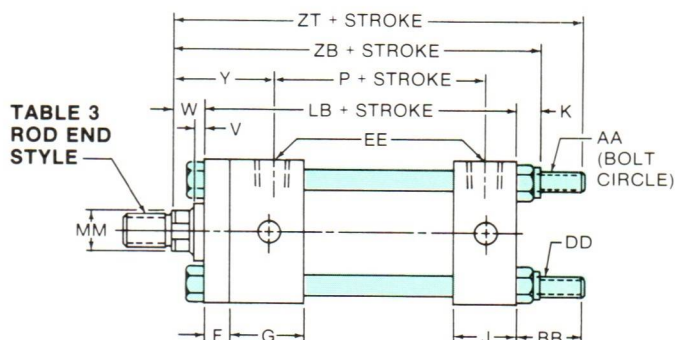
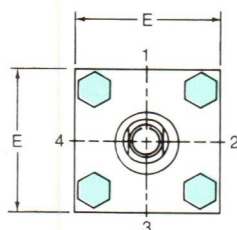
**MODEL LH12  
NFPA STYLE MX3**



## TIE-RODS EXTENDED BLIND END



**MODEL LH13  
NFPA STYLE MX2**





## Dimensional data

(1½"-6" BORE)

**TABLE 1** The dimensions given on this table are affected by the piston rod diameter and the stroke.

BORE DIA.	ROD MM	CYLINDER CODE #	B	LB	P	V	W	Y	ZB	ZT
1½	5/8	51	1⅛	4	2¼	¼	5/8	1⅝/16	5	5⅝/8
	•1	52	1½			½	1	2⅝/16	5⅜/8	6
2	5/8	510	1⅛	4	2¼	¼	5/8	1⅝/16	5⅛/16	5¾/4
	1	511	1½			½	1	2⅝/16	5⅞/16	6⅛/8
	•1⅜	512	2			5/8	1¼	2⅞/16	5⅞/16	6⅜/8
2½	5/8	520	1⅛	4⅞	2⅜	¼	5/8	1⅝/16	5⅜/16	5⅞/8
	1	521	1½			½	1	2⅝/16	5⅞/16	6¼/4
	1⅜	522	2			5/8	1¼	2⅞/16	5⅞/16	6½/2
	•1¾	523	2⅜			¾	1½	2⅞/16	6⅛/16	6¾/4
3¼	1	530	1½	4⅞	2⅝	¼	¾	2⅞/16	6⅛/8	7
	1⅜	531	2			¾	1	2⅞/16	6⅜/8	7¼/4
	1¾	532	2⅜			½	1¼	2⅝/16	6⅝/8	7½/2
	2	533	2⅝			½	1⅜	3⅞/16	6¾/4	7⅝/8
4	1	540	1½	4⅞	2⅝	¼	¾	2⅞/16	6⅛/8	7
	1⅜	541	2			¾	1	2⅞/16	6⅜/8	7¼/4
	1¾	542	2⅜			½	1¼	2⅝/16	6⅝/8	7½/2
	2	543	2⅝			½	1⅜	3⅞/16	6¾/4	7⅝/8
	2½	544	3⅛			5/8	1⅝	3⅝/16	7	7⅞/8
5	1	550	1½	5⅞	2⅞	¼	¾	2⅞/16	6⅞/16	7⅞/16
	1⅜	551	2			¾	1	2⅞/16	6⅞/16	7⅞/16
	1¾	552	2⅜			½	1¼	2⅝/16	6⅝/16	8⅜/16
	2	553	2⅝			½	1⅜	3⅞/16	7⅞/16	8⅝/16
	2½	554	3⅛			5/8	1⅝	3⅝/16	7⅝/16	8⅞/16
	3	555	3¾			5/8	1⅝	3⅝/16	7⅝/16	8⅞/16
6	3½	556	4¼	5¾	3⅞	5/8	1⅝	3⅝/16	7⅝/16	8⅞/16
	1⅜	560	2			¼	7/8	2⅞/16	7⅜/16	8⅞/16
	1¾	561	2⅜			¾	1⅞	3⅞/16	7⅞/16	8⅞/16
	2	562	2⅝			¾	1¼	3⅞/16	7⅞/16	8⅞/16
	2½	563	3⅛			½	1½	3⅞/16	7⅞/16	9⅞/16
	3	564	3¾			½	1½	3⅞/16	7⅞/16	9⅞/16
	3½	565	4¼			½	1½	3⅞/16	7⅞/16	9⅞/16
6	4	566	4¾			½	1½	3⅞/16	7⅞/16	9⅞/16

### HOW TO ORDER

For ordering information refer to Page 22.

### NOTES:

#For double rod end cylinders the cylinder code number is to be written with the letter D. (Refer to page 20.)

•Available with fixed-nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

### CUSHIONS:

The longest cushion is provided that can be accommodated by the rod and blind end caps in any given bore size. Longer cushions are available; for further information consult the factory.

### PORTS:

Series LH cylinders are supplied with NPTF tapered pipe threads as standard. The largest size port is provided that can be accommodated by the rod and blind end caps in any given bore size. For further information on different types of ports or oversized ports refer to page 15.

**TABLE 2** These dimensions are constant regardless of rod diameter or stroke.

BORE DIA.	AA	BB	DD	E	EE	F	G	J	K
1½	2.02	1	¼-28	2	¾	¾	1½	1	¾
2	2.60	1⅞	5/16-24	2½	¾	¾	1½	1	7/16
2½	3.10	1⅞	5/16-24	3	¾	¾	1½	1	7/16
3¼	3.90	1⅞	¾-24	3¾	½	5/8	1¾	1¼	½
4	4.70	1⅞	¾-24	4½	½	5/8	1¾	1¼	½
5	5.80	1⅞	½-20	5½	½	5/8	1¾	1¼	9/16
6	6.90	1⅞	½-20	6½	¾	¾	2	1½	9/16

**SEE TABLE 3  
PAGE 2 FOR  
ROD END STYLES  
AND DIMENSIONS**



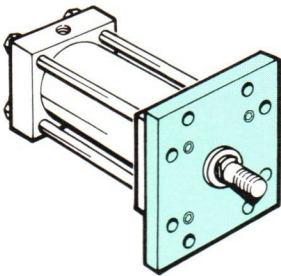
# FLANGE MOUNT

The flange mount is one of the strongest most rigid methods of mounting. With this type of mount there is little allowance for misalignment, though when long strokes are required the free end opposite should be supported to prevent sagging and possible binding of the cylinder. The best use of a blind

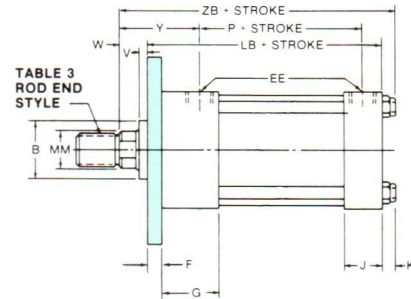
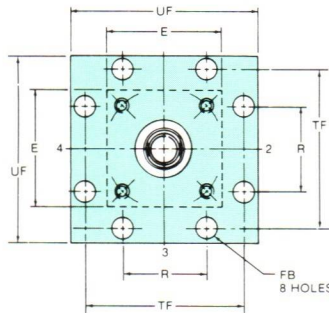
end flange is in a thrust load application (rod in compression). Rod end flange mounts are best used in tension applications. When a less rigid mount can be used and the cylinder can be attached to a panel or bulkhead an extended tie rod mounting could be considered.

FOR PACKAGE AND MOUNTING DIMENSIONS SEE TABLES 1 AND 2

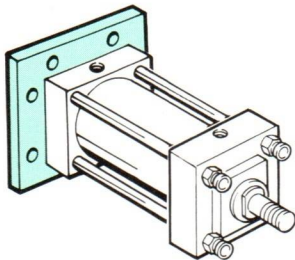
## ROD SQUARE FLANGE MOUNTING



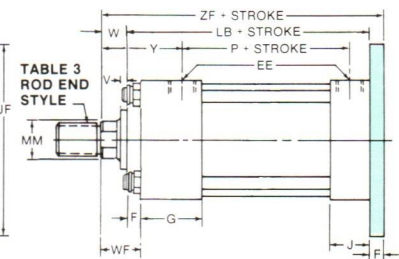
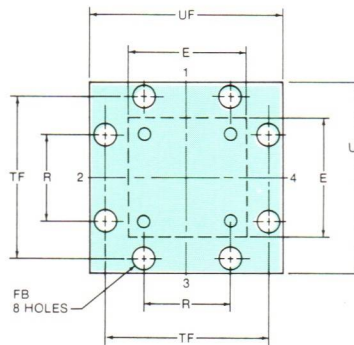
MODEL LH21  
NFPA STYLE MF5



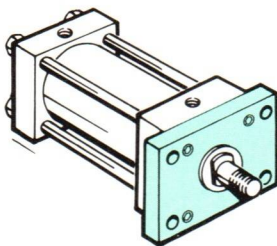
## BLIND SQUARE FLANGE MOUNTING



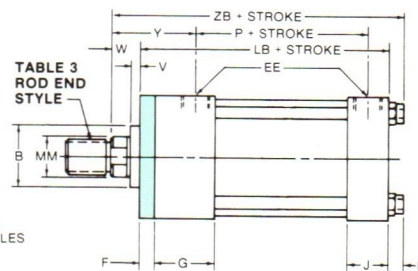
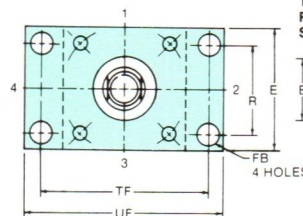
MODEL LH22\*  
NFPA STYLE MF6



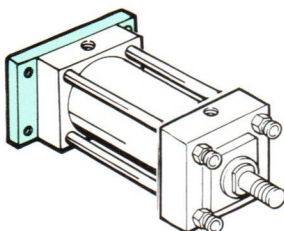
## ROD RECTANGULAR FLANGE MOUNTING



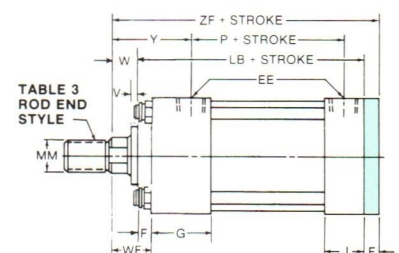
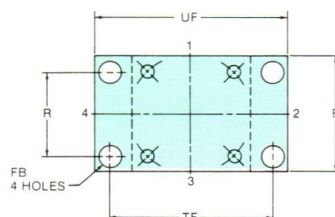
MODEL LH31  
NFPA STYLE MF1



## BLIND RECTANGULAR FLANGE MOUNTING



MODEL LH32  
NFPA STYLE MF2





## Dimensional data

(1½"-6" BORE)

**TABLE 1**

The dimensions given on this table are affected by the piston rod diameter and the stroke.

BORE DIA.	ROD MM	CYLINDER CODE #	B	LB	P	V	W	WF	Y	ZB	ZF
1½	⅝	51	1⅛	4	2¼	¼	⅝		1⅝/16	5	5
	• 1 *	52	1½			½	1		2⅝/16	5⅜	5⅜
2	⅝	510	1⅛	4	2¼	¼	⅝		1⅝/16	5⅛	5
	1	511	1½			½	1		2⅝/16	5⅞	5⅜
	• 1⅜ *	512	2			⅝	1¼		2⅞/16	5⅞/16	5⅝
2½	⅝	520	1⅛	4⅞	2⅜	¼	⅝		1⅝/16	5⅜	5⅞
	1	521	1½			½	1		2⅝/16	5⅞	5½
	1⅜	522	2			⅝	1¼		2⅞/16	5⅞/16	5¾
	• 1¾ *	523	2⅜			¾	1½		2⅞/16	6⅞	6
3¼	1	530	1½	4⅞	2⅝	¼	¾		2⅞/16	6⅞	6¼
	1⅜	531	2			⅜	1	1⅝	2⅞/16	6⅞	6½
	1¾	532	2⅜			½	1¼	1⅞	2⅞/16	6⅞	6¾
	2 *	533	2⅝			½	1⅜	2	3⅞/16	6¾	6⅞
4	1	540	1½	4⅞	2⅝	¼	¾		2⅞/16	6⅞	6¼
	1⅜	541	2			⅜	1		2⅞/16	6⅞	6½
	1¾	542	2⅜			½	1¼	1⅞	2⅞/16	6⅞	6¾
	2	543	2⅝			½	1⅜	2	3⅞/16	6¾	6⅞
	2½ *	544	3⅞			⅝	1⅝	2¼	3⅞/16	7	7⅞
5	1	550	1½	5⅞	2⅞	¼	¾		2⅞/16	6⅞	6½
	1⅜	551	2			⅜	1		2⅞/16	6⅞	6¾
	1¾	552	2⅜			½	1¼		2⅞/16	6⅞	7
	2	553	2⅝			½	1⅜	2	3⅞/16	7⅞	7⅞
	2½	554	3⅞			⅝	1⅝	2¼	3⅞/16	7⅞	7⅞
	3	555	3¾			⅝	1⅝	2¼	3⅞/16	7⅞	7⅞
6	3½ *	556	4¼	5¾	3⅞	⅝	1⅝	2¼	3⅞/16	7⅞	7⅞
	1⅜	560	2			¼	⅞		2⅞/16	7⅞	7⅞
	1¾	561	2⅜			⅜	1⅞		3⅞/16	7⅞	7⅞
	2	562	2⅝			⅜	1¼		3⅞/16	7⅞	7¾
	2½	563	3⅞			½	1½	2¼	3⅞/16	7⅞	8
	3	564	3¾			½	1½	2¼	3⅞/16	7⅞	8
	3½	565	4¼			½	1½	2¼	3⅞/16	7⅞	8
	4	566	4¾			½	1½	2¼	3⅞/16	7⅞	8

### HOW TO ORDER

For ordering information refer to Page 22.

### NOTES:

#For double rod end cylinders the cylinder code number is to be written with the letter D. (Refer to page 20.)

• Available with fixed-nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

\*Removable retainer not available for these bore and rod combinations in the LH22 and LH32 mounting styles.

### PORTS:

Series LH cylinders are supplied with NPTF tapered pipe threads as standard. The largest size port is provided that can be accommodated by the rod and blind end caps in any given bore size. For further information on different types of ports or oversized ports refer to page 15.

### CUSHIONS:

The longest cushion is provided that can be accommodated by the rod and blind end caps in any given bore size. Longer cushions are available; for further information consult the factory.

**TABLE 2**

These dimensions are constant regardless of rod diameter or stroke.

BORE DIA.	E	EE	F	FB	G	J	K	R	TF	UF
1½	2	⅜	⅜	⅝/16	1½	1	⅜	1.43	2¾	3⅜
2	2½	⅜	⅜	⅜	1½	1	7/16	1.84	3⅜	4⅞
2½	3	⅜	⅜	⅜	1½	1	7/16	2.19	3⅜	4⅝
3¼	3¾	½	⅝	7/16	1¾	1¼	½	2.76	4⅞/16	5½
4	4½	½	⅝	7/16	1¾	1¼	½	3.32	5⅞/16	6¼
5	5½	½	⅝	9/16	1¾	1¼	9/16	4.10	6⅞	7⅝
6	6½	¾	¾	9/16	2	1½	9/16	4.88	7⅞	8⅝

SEE TABLE 3  
PAGE 2 FOR  
ROD END STYLES  
AND DIMENSIONS



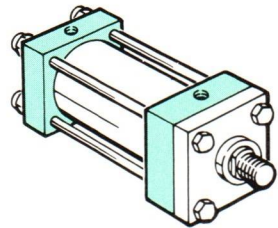
# SIDE AND LUG MOUNTS

The side or lug mounted cylinder provides a fairly rigid mount. These types of cylinders can tolerate a slight amount of misalignment when the cylinder is at full stroke, but as the piston moves toward the blind end the tolerance for

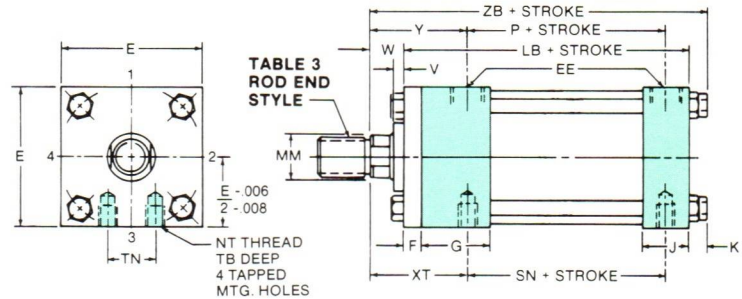
misalignment decreases. It is important to note that if the cylinder is used properly (without misalignment) the mounting bolts are either in simple shear or tension without any compound stresses.

FOR PACKAGE AND MOUNTING DIMENSIONS SEE TABLES 1 AND 2

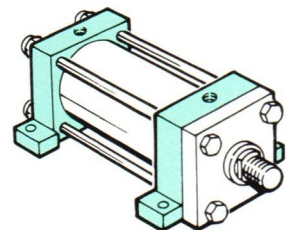
## TAPPED HOLES IN CAPS FLUSH MOUNTING



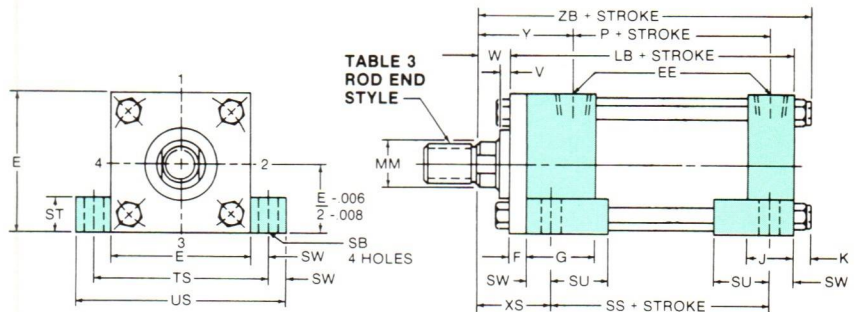
**MODEL LH41**  
**NFPA STYLE MS4**



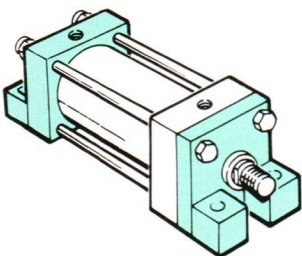
## SIDE LUG MOUNTING



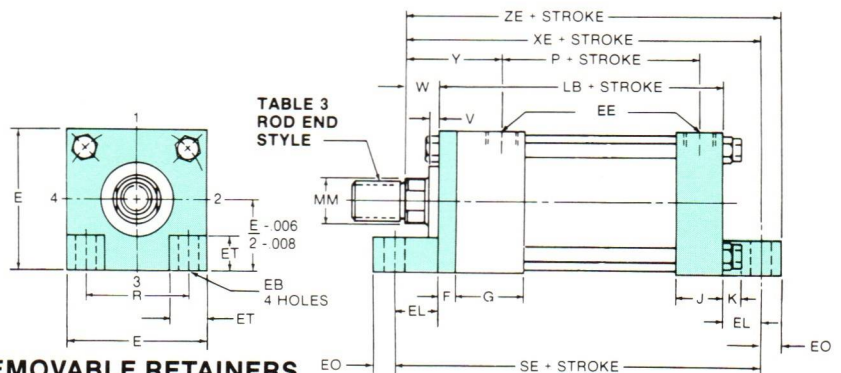
**MODEL LH42**  
**NFPA STYLE MS2**



## FOOT MOUNTING

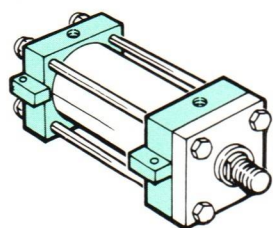


**MODEL LH43**  
**NFPA STYLE MS7**

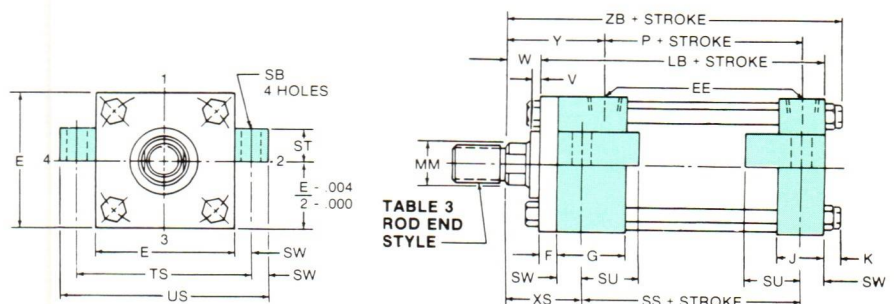


NOT AVAILABLE WITH REMOVABLE RETAINERS

## CENTERLINE LUG MOUNTING



**MODEL LH51**  
**NFPA STYLE MS3**





## Dimensional data (1½"-6" BORE)

**TABLE 1**

The dimensions given on this table are affected by the piston rod diameter and the stroke.

BORE DIA.	ROD MM	CYLINDER CODE #	LB	P	SE†	SN	SS■	V	W	XE	XS	XT	Y	ZB	ZE
1½	5/8	51	4	2¼	5½	2¼	27/8	¼	5/8	53/8	13/8	115/16	115/16	5	55/8
	★1	52						½	1	5¼	1¼	25/16	25/16	53/8	6
2	5/8	510	4	2¼	57/8	2¼	27/8	¼	5/8	59/16	13/8	115/16	115/16	51/16	57/8
	★1	511						½	1	515/16	1¼	25/16	25/16	57/16	6¼
	★13/8	512						5/8	1¼	63/16	2	29/16	29/16	511/16	6½
2½	5/8	520	4½	23/8	6¼	23/8	3	¼	5/8	513/16	13/8	115/16	115/16	53/16	61/8
	1	521						½	1	63/16	1¼	25/16	25/16	59/16	6½
	★13/8	522						5/8	1¼	67/16	2	29/16	29/16	513/16	6¾
	★1¾	523						¾	1½	611/16	2¼	213/16	213/16	61/16	7
3¼	1	530	47/8	25/8	65/8	25/8	3¼	¼	¾	61/2	17/8	27/16	27/16	61/8	67/8
	13/8	531						3/8	1	6¾	21/8	211/16	211/16	63/8	71/8
	★1¾	532						½	1¼	7	23/8	215/16	215/16	65/8	73/8
	★2	533						½	13/8	71/8	2½	31/16	31/16	6¾	7½
4	1	540	47/8	25/8	67/8	25/8	3¼	¼	¾	65/8	17/8	27/16	27/16	61/8	7
	13/8	541						3/8	1	67/8	21/8	211/16	211/16	63/8	7¼
	1¾	542						½	1¼	71/8	23/8	215/16	215/16	65/8	7½
	2	543						½	13/8	7¼	2½	31/16	31/16	6¾	75/8
	★2½	544						5/8	15/8	7½	2¾	35/16	35/16	7	77/8
5	1	550	51/8	27/8	7¼	27/8	33/8	¼	¾	615/16	21/16	27/16	27/16	67/16	71/16
	13/8	551						3/8	1	73/16	25/16	211/16	211/16	611/16	711/16
	1¾	552						½	1¼	77/16	29/16	215/16	215/16	615/16	715/16
	2	553						½	13/8	79/16	211/16	31/16	31/16	71/16	81/16
	2½	554						5/8	15/8	713/16	215/16	35/16	35/16	75/16	85/16
	3	555						5/8	15/8	713/16	215/16	35/16	35/16	75/16	85/16
	★3½	556						5/8	15/8	713/16	215/16	35/16	35/16	75/16	85/16
6	13/8	560	53/4	31/8	7¾	31/8	35/8	¼	7/8	75/8	25/16	213/16	213/16	73/16	81/8
	1¾	561						3/8	11/8	77/8	29/16	31/16	31/16	77/16	83/8
	2	562						3/8	1¼	8	211/16	33/16	33/16	79/16	8½
	2½	563						½	1½	8¼	215/16	37/16	37/16	713/16	8¾
	3	564						½	1½	8¼	215/16	37/16	37/16	713/16	8¾
	3½	565						½	1½	8¼	215/16	37/16	37/16	713/16	8¾
	★4	566						½	1½	8¼	215/16	37/16	37/16	713/16	8¾

### HOW TO ORDER

For ordering information refer to Page 22.

### NOTES:

★ Model LH41 is not available in these sizes.

† The standard rod eye or rod clevis will interfere with foot lugs on Model LH43. When these rod end accessories are required use additional rod extension.

‡ For double rod end cylinders from 1½" thru 6" bore add ½" + F to this dimension.

■ For double rod end cylinders from 1½" thru 6" bore add ½" to this dimension.

• Available with fixed non-adjustable cushions on rod end and standard adjustable cushions on the blind end only.

# For double rod end cylinders the cylinder code number is to be written with the letter D before it. (Refer to page 20.)

### PORTS:

Series LH cylinders are supplied with NPTF tapered pipe threads as standard. The largest size port is provided that can be accommodated by the rod and blind end caps in any given bore size. For further information on different types of ports or oversized ports refer to page 15.

### CUSHIONS:

The longest cushion is provided that can be accommodated by the rod and blind end caps in any given bore size. Longer cushions are available; for further information consult the factory.

**SEE TABLE 3  
PAGE 2 FOR  
ROD END STYLES  
AND DIMENSIONS**

**TABLE 2**

These dimensions are constant regardless of rod diameter or stroke.

BORE DIA.	E	EB	EE	EL	EO	ET	F	G	J	K	NT	R	SB	ST	SU	SW	TB	TN	TS	US
1½	2	5/16	3/8	¾	1/4	1/2	3/8	1½	1	3/8	¼-20	1.43	7/16	½	15/16	3/8	3/8	5/8	2¾	3½
2	2½	3/8	3/8	15/16	5/16	19/32	3/8	1½	1	7/16	5/16-18	1.84	7/16	½	15/16	3/8	9/16	7/8	3¼	4
2½	3	3/8	3/8	11/16	5/16	¾	3/8	1½	1	7/16	3/8-16	2.19	7/16	½	15/16	3/8	5/8	1¼	3¾	4½
3¼	3¾	7/16	½	7/8	3/8	29/32	5/8	1¾	1¼	½	1/2-13	2.76	9/16	¾	1¼	½	¾	1½	4¾	5¾
4	4½	7/16	½	1	3/8	11/8	5/8	1¾	1¼	½	1/2-13	3.32	9/16	¾	1¼	½	1	21/16	5½	6½
5	5½	9/16	½	11/16	½	111/32	5/8	1¾	1¼	9/16	5/8-11	4.10	13/16	1	19/16	11/16	1	211/16	67/8	8¼
6	6½	9/16	¾	1	½	19/16	¾	2	1½	9/16	¾-10	4.88	13/16	1	19/16	11/16	11/8	3¼	77/8	9¼

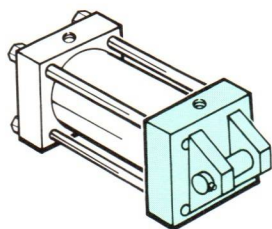


# PIN AND TRUNNION MOUNTS

All pin and trunnion cylinders need a provision on both ends for pivoting. These types of cylinders are designed to carry shear loads and

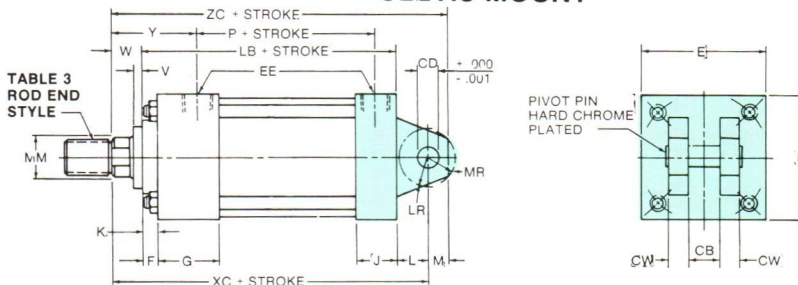
the trunnion and pivot pins should be carried by bearings that are rigidly held and closely fit for the entire length of the pin.

FOR PACKAGE AND MOUNTING DIMENSIONS SEE TABLES 1 AND 2

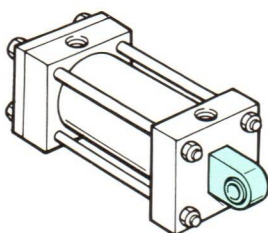
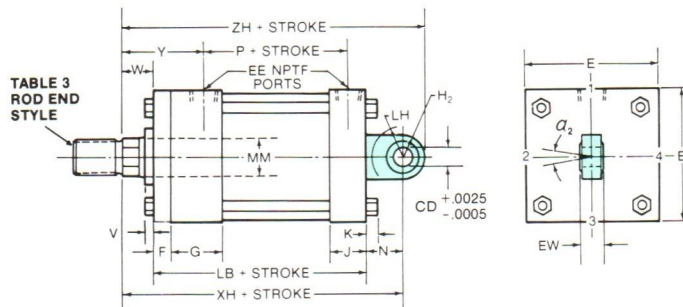


**MODEL LH61  
NFPA STYLE MP1**

## CLEVIS MOUNT

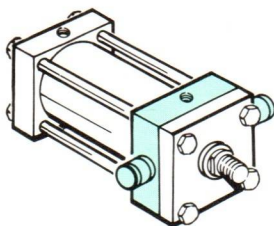
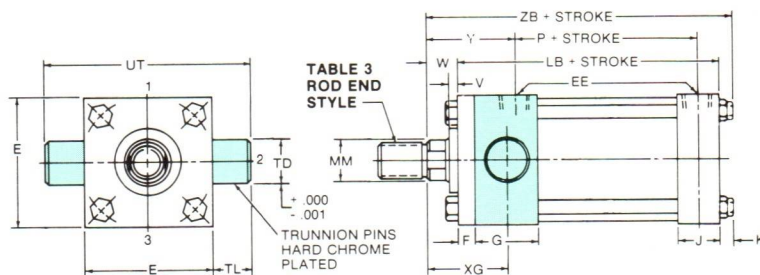


## FIXED EYE MOUNT



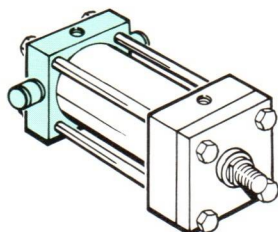
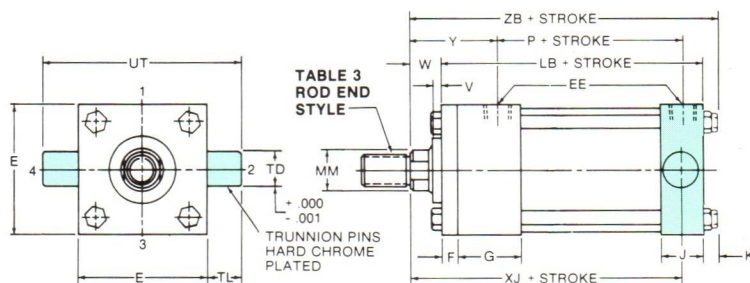
**MODEL LH62**

## ROD END TRUNNION MOUNT



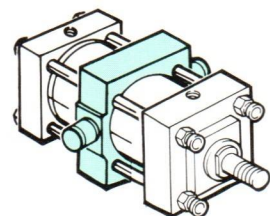
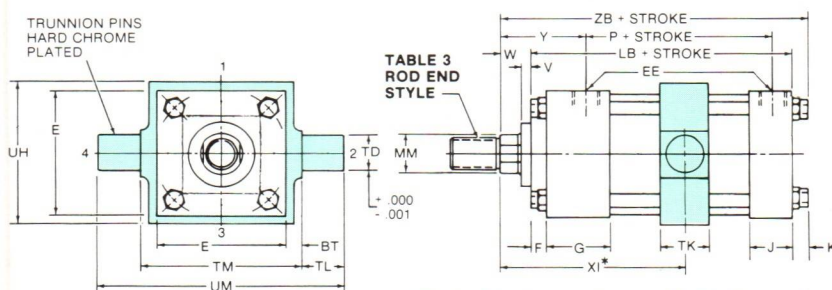
**MODEL LH71  
NFPA STYLE MT1**

## BLIND END TRUNNION MOUNT



**MODEL LH72  
NFPA STYLE MT2**

## CENTER TRUNNION MOUNT



**MODEL LH73  
NFPA STYLE MT4**

\*Note: Customer to specify XI dimension



## Dimensional data

(1½-6" BORE)

**TABLE 1**

The dimensions given on this table are affected by the piston rod diameter and the stroke.

BORE DIA.	ROD MM	CYLINDER CODE #	LB	P	V	W	XC	XG	XH	XJ	Y	ZB	ZC	ZH
1½	5/8	51	4	2¼	¼	5/8	5¾	1¾	5½	4⅞	1⅝/16	5	5⅞	6¼
	•1 *	52			½	1	5¾	2⅞	5⅞	4½	2⅝/16	5¾	6¼	6⅝
2	5/8	510	4	2¼	¼	5/8	5¾	1¾	5½	4⅞	1⅝/16	5⅞	5⅞	6¼
	1	511			½	1	5¾	2⅞	5⅞	4½	2⅝/16	5⅞	6¼	6⅝
	•1¾ *	512			5/8	1¼	6	2¾	6⅞	4¾	2⅞/16	5⅞	6½	6⅞
2½	5/8	520	4⅞	2¾	¼	5/8	5½	1¾	5⅝	4¼	1⅝/16	5⅞	6	6¾
	1	521			½	1	5⅞	2⅞	6	4⅝	2⅝/16	5⅞	6¾	6¾
	1¾	522			5/8	1¼	6⅞	2¾	6¼	4⅞	2⅞/16	5⅞	6⅝	7
	•1¾ *	523			¾	1½	6¾	2⅝	6¾	5⅞	2⅞/16	6⅞	6⅞	7⅞
3¼	1	530	4⅞	2⅝	¼	¾	6⅞	2¼	6⅞	5	2⅞/16	6⅞	7⅝	8⅞
	1¾	531			¾	1	7⅞	2½	7⅞	5¼	2⅞/16	6⅞	7⅞	8¾
	1¾	532			½	1¼	7¾	2¾	7¾	5½	2⅝/16	6⅞	8⅞	8⅝
	2 *	533			½	1¾	7½	2⅞	7½	5⅝	3⅞/16	6¾	8¼	8¾
	2½ *	544			5/8	1⅝	7¾	3⅞	7¾	5⅞	3⅞/16	7	8½	9
4	1	540	4⅞	2⅝	¼	¾	6⅞	2¼	6⅞	5	2⅞/16	6⅞	7⅝	8⅞
	1¾	541			¾	1	7⅞	2½	7⅞	5¼	2⅞/16	6⅞	7⅞	8¾
	1¾	542			½	1¼	7¾	2¾	7¾	5½	2⅝/16	6⅞	8⅞	8⅝
	2	543			½	1¾	7½	2⅞	7½	5⅝	3⅞/16	6¾	8¼	8¾
	2½ *	544			5/8	1⅝	7¾	3⅞	7¾	5⅞	3⅞/16	7	8½	9
5	1	550	5⅞	2⅞	¼	¾	7⅞	2¼	7⅞	5¼	2⅞/16	6⅞	7⅞	8¾
	1¾	551			¾	1	7¾	2½	7¾	5½	2⅞/16	6⅞	8⅞	8⅝
	1¾	552			½	1¼	7¾	2¾	7¾	5¾	2⅝/16	6⅞	8¾	8⅞
	2	553			½	1¾	7¾	2⅞	7¾	5⅞	3⅞/16	7⅞	8½	9
	2½	554			5/8	1⅝	8	3⅞	8	6⅞	3⅞/16	7⅞	8¾	9¼
	3	555			5/8	1⅝	8	3⅞	8	6⅞	3⅞/16	7⅞	8¾	9¼
6	3½ *	556	5¾	3⅞	5/8	1⅝	8	3⅞	8	6⅞	3⅞/16	7⅞	8¾	9¼
	1¾	560			¼	7/8	8⅞	2⅝	8¼	5⅞	2⅞/16	7⅞	9⅞	10
	1¾	561			¾	1⅞	8¾	2⅞	8½	6⅞	3⅞/16	7⅞	9¾	10¼
	2	562			¾	1¼	8½	3	8⅝	6¼	3⅞/16	7⅞	9½	10¾
	2½	563			½	1½	8¾	3¼	8⅞	6½	3⅞/16	7⅞	9¾	10⅝
	3	564			½	1½	8¾	3¼	8⅞	6½	3⅞/16	7⅞	9¾	10⅝
	3½	565			½	1½	8¾	3¼	8⅞	6½	3⅞/16	7⅞	9¾	10⅝
	4	566			½	1½	8¾	3¼	8⅞	6½	3⅞/16	7⅞	9¾	10⅝

### HOW TO ORDER

For ordering information refer to Page 22

### NOTES:

#For double rod end cylinders the cylinder code number is to be written with the letter D. (Refer to page 20.)

•Available with fixed-nonadjustable cushions on rod end and standard adjustable cushions on the blind end only.

\*Removable retainer not available for these bore and rod combinations in the LH61 and LH73 mounting styles.

### PORTS:

Series LH cylinders are supplied with NPTF tapered pipe threads as standard. The largest size port is provided that can be accommodated by the rod and blind end caps in any given bore size. For further information on different types of ports or oversized ports refer to page 15.

### CUSHIONS:

The longest cushion is provided that can be accommodated by the rod and blind end caps in any given bore size. Longer cushions are available; for further information consult the factory.

SEE TABLE 3  
PAGE 2 FOR  
ROD END STYLES  
AND DIMENSIONS

**TABLE 2**

These dimensions are constant regardless of rod diameter or stroke.

BORE DIA.	a <sub>2</sub>	BT	CB	CD	CW	E	EE	EW	F	G	H <sub>2</sub>	J	K	L	LH	LR	M	MR	N	TD	TK	TL	TM	UH	UM	UT
1½	13°	¾	¾	½	½	2	¾	5/8	¾	1½	1¾	1	¾	¾	5/8	5/8	½	2⅞/32	7/8	1	1⅞	1	3½	2¾	5½	4
2	13°	¾	¾	½	½	2½	¾	5/8	¾	1½	1¾	1	7/16	¾	5/8	5/8	½	1⅞/16	7/8	1	1⅞	1	4	2⅞	6	4½
2½	13°	¾	¾	½	½	3	¾	5/8	¾	1½	1¾	1	7/16	¾	5/8	5/8	½	1⅞/16	7/8	1	1⅞	1	4½	3¾	6½	5
3¼	14°	¾	1¼	¾	5/8	3¾	½	7/8	5/8	1¾	1¼	½	1¼	1	1⅞/16	¾	¾	1⅞/16	1¼	1	1¼	1	5¼	4⅞	7¼	5¾
4	14°	¾	1¼	¾	5/8	4½	½	7/8	5/8	1¾	1¼	½	1¼	1	1⅞/16	¾	¾	1⅞/16	1¼	1	1¼	1	6	5	8	6½
5	14°	¾	1¼	¾	5/8	5½	½	7/8	5/8	1¾	1¼	½	1¼	1	1⅞/16	¾	¾	1⅞/16	1¼	1	1¼	1	7	6	9	7½
6	12½°	1	1½	1	¾	6½	¾	1¾	¾	2	1¾	1½	9/16	1½	1¼	1¼	1	1	1⅞/8	1¾	1½	1¾	8½	7	11¼	9¼



## Modifications

## Design options

### Special Cylinders

MILWAUKEE CYLINDER has two basic product identities. The first, as a supplier of standard Hydraulic and Air Cylinders. The second as a specialist in the design and manufacture of totally unique cylinders to suit the wide range of applications for cylinders being developed into today's industry. Milwaukee is a customer and engineering orientated company which gladly welcomes a challenge to meet every customer's unique needs in the area of specials. For information on what data is required by Milwaukee to develop a design to suit your needs contact either your local Milwaukee representative or the factory.

### Special Rod Ends

Modifications of standard or entirely special rod ends are available from Milwaukee at a slightly additional charge. When your requirements call for a special rod end style your order should include a sketch if it is to be an entirely special rod end or note reference as to which letter dimensions you wish to have modified (ref. pg. 2, 6-13 and 23).

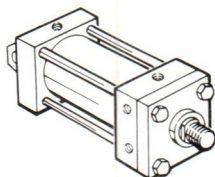
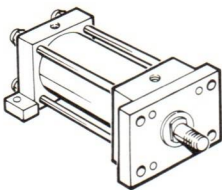
### Special Assemblies From Standard Parts

This catalog was designed to aid in communication and simplify the placing of orders by our customers. On pages 2, 6-13 and 23 each style, of the various standard cylinder mountings, is illustrated using the commonly recognized cylinder dimensional symbols of the National Fluid Power Association. Each side of the end views are numbered to aid in communication when referring to the relationship between the ports and the mountings. When requesting information or placing an order that requires a dimension other than standard, always make reference to the given dimensional symbol in the catalog and then give your requirements.

### Combined Mountings

Standard mountings may be combined when specified by the customer. Some examples of this are:

1. An LH31 mount constructed with an LH42 mount blind end cap.

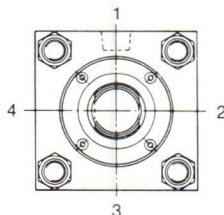


2. An LH61 mount constructed with an LH41 mount rod end cap.

These and other combinations can be readily made from standard parts. If you are unsure of a possible combination or if it will suit your particular needs consult with your local Milwaukee representative or contact the factory.

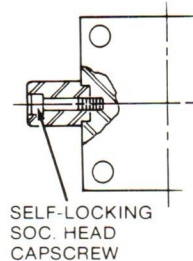
### Cushion Adjustment Locations

A ball check is supplied as standard in position #4 and a cushion adjustment needle is supplied as standard in position #2 on most models. The cushion needle and ball check are interchangeable as far as location and may be put in any side not occupied by a port or mounting.



### Removable Trunnion Pins

If specified by the customer removable trunnion pins are available on models LH71 & LH72 at a slightly additional cost. It is possible to have this type of trunnion pin on all bore and rod combinations, except on the largest oversize rod offered with each bore size on all model LH71 cylinders.



### Single Acting Cylinders

The Milwaukee Series "LH" cylinders are designed for either single or double action. When used as a single acting cylinder, hydraulic power drives the piston in one direction only relying on either the load or an external force to return the piston after the pressure is exhausted.

### Single Acting-spring Cylinders

Single acting spring return cylinders normally have a spring inside of the cylinder to return the piston to its original position. The application load and friction conditions must be specified when placing an order to properly size the spring. Also specify whether the spring is to return or advance the piston. A spring return cylinder is designed with a stop tube to act as a spring guide which prevents binding of the cylinder, due to mis-alignment of the spring. To accurately determine the cylinder length and mounting dimensions for your application contact your local Milwaukee Representative or the factory.

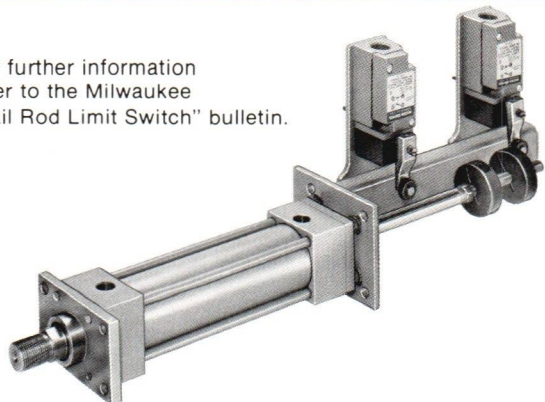
### Water Service Cylinders

Milwaukee Series "LH" cylinders can be used with water as an operating fluid with some standard modifications to the types of material and the manufacturing processes used. These modifications will include, at some additional cost, an aluminum piston, nickel plated end caps, a hard chrome plated cylinder barrel, and a chrome plated piston rod or stainless steel piston rod. Due to the increased factors of corrosion, electrolysis, and mineral deposits acting within a water fitted cylinder, Milwaukee cannot warrant or make any guarantees other than a water service cylinder will be free of defects in workmanship or materials.

### Tail Rod-Limit Switch Cylinder

This unique design incorporates a standard Milwaukee series "LH" double rod end cylinder with a limit switch "actuator accessory". Primarily this design is to be used on 1½ thru 6" bore cylinders of 12" or less stroke.

For further information  
refer to the Milwaukee  
"Tail Rod Limit Switch" bulletin.





### PORTS

#### Standard Ports

The Milwaukee Series "LH" cylinders are manufactured as standard, with NPTF tapered pipe thread ports of the largest size that will fit in both the rod and blind ends of a given bore size. Upon request extra ports can be provided on the sides of the end caps not occupied by mountings or cushion adjusters.

#### Oversize Ports

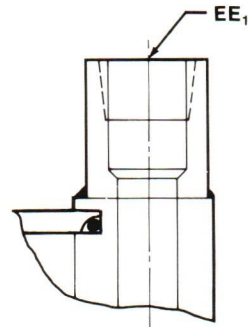
On most bore sizes, welded bosses may be provided for oversize NPTF ports. These bosses protrude from the sides of the end caps. For information as to the boss height, in relation to your bore and port requirements, contact your local Milwaukee Representative. Also special end caps can be provided, at additional cost, which are heavier so that oversize ports can be accommodated without the use of a welded boss.

#### Straight Thread Ports

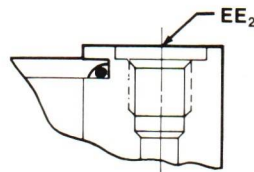
On request Milwaukee will furnish an S.A.E. straight thread O-ring port with its Series "LH" cylinders. In addition to the standard oversize NPTF ports welded bosses may also be used for oversize S.A.E. straight thread O-ring ports. For further information on oversize S.A.E. ports contact the factory.

Note:

Flange and manifold style ports are available from Milwaukee at a slightly additional charge.



Oversize port  
Welded boss

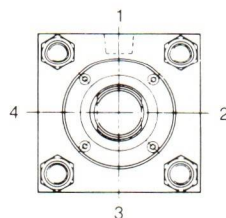


SAE straight  
thd. O-ring port

BORE	STD. NPTF PORT EE	OVER- SIZE NPTF PORT EE <sub>1</sub>	SAE STRAIGHT O-RING PORT	
			EE <sub>2</sub>	SAE STR. THD. SERIES
1½	⅜	½	# 6	⅝-18
2	⅜	½	# 6	⅝-18
2½	⅜	½	# 6	⅝-18
3¼	½	¾	#10	⅞-14
4	½	¾	#10	⅞-14
5	½	¾	#10	⅞-14
6	¾	1	#12	1½-12

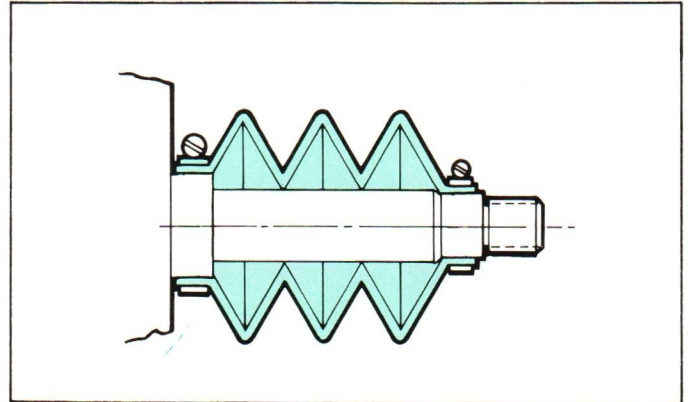
#### Port Locations

Ports are located in position #1 as standard unless otherwise specified by the customer. By using the position numbers given with the end views in the dimensional data section of this catalog, ports can be arranged in anyone of four 90 degree positions in relation to the cylinder mounting without charge. When ports are relocated on a cushioned cylinder the cushion needle and ball check are automatically relocated to hold their relationship to the port as on a standard cylinder unless otherwise specified at the time of the order.



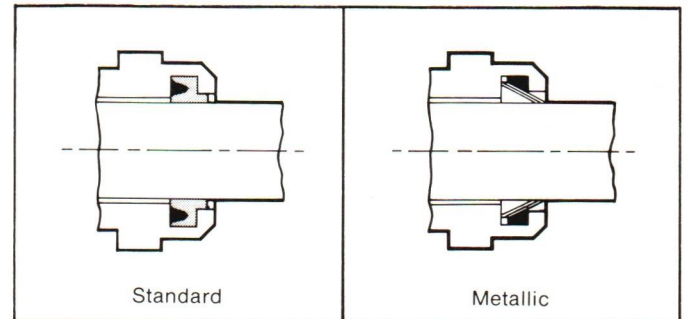
#### Rod Boots

When cylinders are used in areas of high contamination or where contaminants have an air hardening property the exposed piston rod should be covered with a rod boot to protect the rod bearing and seals. A rod boot is simply a collapsible cover used for such an application. It is of sewn construction made from a neoprene coated fabric. The rod boots are impervious to oil, grease, and water. They will operate effectively from 0 degrees F to +200 degrees F without cracking.



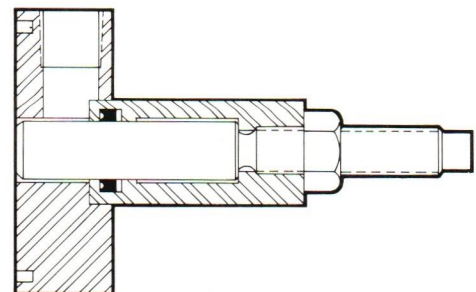
#### Metallic Rod Wipers

Metallic rod wipers will be supplied in place of the standard synthetic rubber wiper when specified at the time of order. This type of seal is recommended for applications where contaminants would tend to cling to the rod and damage a standard synthetic rubber rod wiper.



#### Adjustable Stroke Cylinders

When a cylinder application requires stroke adjustment Milwaukee offers a number of designs, the most common of which is illustrated below. This particular design is externally adjustable incorporating a threaded rod (of piston rod quality) with the standard hydraulic rod end multiple lip vee seal and bushing design. This provides a proven-effective high and low pressure seal affording maximum sealing on the stroke adjustment rod.



Further information concerning design limitations, cushioning, or alternate designs can be obtained by contacting the factory.



# Engineering Data

## Stop Tube

Stop tubes are used to maintain bearing pressure within acceptable limits and are recommended on cylinders with long strokes or poorly guided rods.

The stop tube is a spacer between the rod end cap and the piston, which provides separation between the piston and the rod bearing. This separation reduces the moment forces developed between the rod bearing and piston when the rod is extended.

To determine if stop tube is necessary for your cylinder requirements you have to solve for "K" (refer to table 4). If your required cylinder has a "K" dimension in excess of 40 inches, stop tube is required. For each 10 inch increment or fraction thereof in excess of 40 inches, one inch of stop tube is recommended. When stop tube is required the overall length of the cylinder will be increased by the length of the stop tube to be used.

To Determine "K" (refer to table #4)

\*note: W = the rod stick out (refer to pages 7 thru 13)

Cylinder #1, #4, #8 - from Table 4

$$K = 4L = 4 (\text{stroke} + W^*)$$

Cylinder #2 - from Table 4

$$K = L = (CA \text{ or } CE) + XG + \text{Stroke}$$

note: CA = rod eye dimension page 23

CE = rod clevis dimension page 23

XG = Mounting dimension page 13

Cylinder #3 - from Table 4

$$K = L = W^* + \text{Stroke}$$

Cylinder #5 - from Table 4

$$K = L = (CA \text{ or } CE) + XC + (2 \times \text{Stroke})$$

note: CA = rod eye dimension page 23

CE = rod clevis dimension page 23

XC = Mounting dimension page 13

Cylinder #6 - from Table 4

$$K = L = (CA \text{ or } CE) + XJ + (2 \times \text{Stroke})$$

note: CA = rod eye dimension page 23

CE = rod clevis dimension page 23

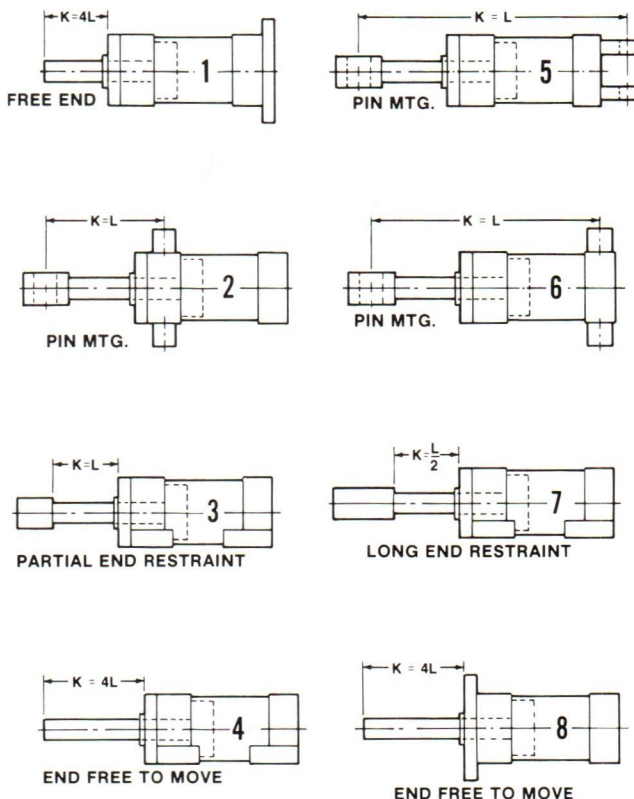
XJ = Mounting dimension page 13

Cylinder #7 - from Table 4

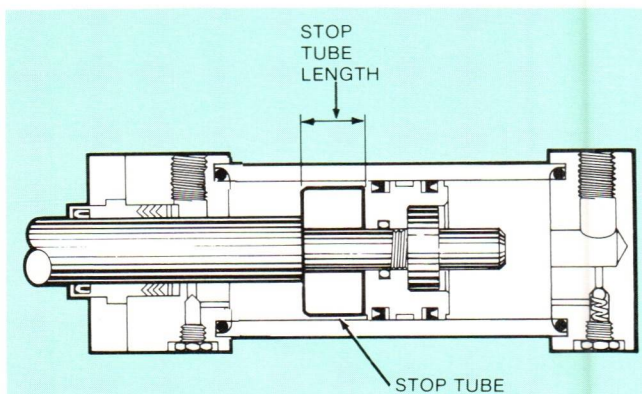
$$K = L/2 = (W^* + \text{Stroke})/2$$

**NOTE: Stop tube length must be added to "K" factor before making final selection of rod size. This is primarily true in No. 5 long stroke applications.**

**STROKE TO MOUNTING RELATIONSHIP**  
**TABLE 4 — ALL RODS IN EXTENDED POSITION**



When mounting long stroke cylinders care should be taken to assure cylinder alignment over the entire length of stroke. The use of external guides or swivel bushings is recommended to reduce side load conditions and prolong the cylinders service life.



The stop tube is located between the piston and the rod end cap. It limits the extended stroke of the cylinder providing additional strength for less cost and reduced weight, than the use of an oversize rod.

**TABLE 5 — VALUE OF "K" IN INCHES**

THRUST FORCE In. Lbs.	PISTON ROD DIAMETER											
	5/8"	1"	1 1/8"	1 3/4"	2"	2 1/2"	3"	3 1/2"	4"	4 1/2"	5"	5 1/2"
400	35	84	134									
700	30	68	119									
1,000	26	60	105	156	190							
1,400	24	54	93	144	175	244	308					
1,800	23	48	84	127	160	230	294	366				
2,400	18	45	75	114	145	214	281	347				
3,200	16	40	68	103	131	196	262	329	396			
4,000	12	38	63	93	119	174	240	310	373	446		
5,000	9	36	60	87	112	163	225	289	359	426		
6,000	30	56	82	102	152	209	274	342	411	476		
8,000	25	51	76	93	136	186	244	310	375	448		
10,000	21	45	70	89	125	172	221	279	349	412		
12,000	17	41	64	85	117	155	210	270	326	388	455	
16,000			35	57	75	110	141	188	233	291	350	421
20,000			28	52	66	103	136	173	218	270	325	385
30,000				39	56	87	120	156	190	232	285	330
40,000				24	43	75	108	142	177	210	248	293



# Engineering Data

## Rod Size Selection

"Milwaukee" Series "LH" Cylinders incorporate a high strength, surface hardened rod. Standard rod sizes are generally suitable for most applications, however, on long stroke or high thrust applications, the selection of minimum rod size should be checked using the following steps:

1. Knowing bore size, stroke, and push thrust (refer to Table No. 7 below), determine the overall length between mounting points, Table 1, pages 7-13. Equate determined overall length to "L".
2. Select from Table 2, pages 7-13, the type mounting being used and determine the equivalent length dimension "K". (Refer to page 16.)
3. Refer to Table 5, page 16 and using thrust load and developed "K" dimension, select rod size.
4. If oversize rod is required, re-check overall length dimension as determined in step No. 1. There will be a slight change which generally will not affect the "Size Determination" calculations, but must be considered in the cylinder installation.

**TABLE 6 — DEDUCTIONS FOR PULL STROKE FORCE AND DISPLACEMENT**

Rod Size	Rod Area Sq. In.	ROD DIAMETER FORCE IN POUNDS FOR VARIOUS LINE PRESSURES							DISPLACEMENT Per Inch of Stroke	
		100	250	500	750	1000	1250	1500	Cu. Inch	Gallons
5/8	.307	31	77	155	232	310	387	465	.307	.0013
1	.785	79	197	395	592	790	987	1185	.785	.0034
1 1/8	1.485	149	372	745	1117	1490	1862	2230	1.485	.0064
1 3/4	2.405	241	601	1203	1804	2410	3011	3613	2.405	.0104
2	3.142	314	785	1570	2355	3140	3925	4710	3.142	.0136
2 1/2	4.909	491	1227	2455	3682	4910	6137	7365	4.909	.0213
3	7.069	707	1767	3535	5302	7070	8837	10605	7.069	.0306
3 1/2	9.621	962	2405	4810	7215	9620	12025	14430	9.621	.0416
4	12.566	1257	3142	6285	9427	12570	15712	18855	12.566	.0544
4 1/2	15.904	1590	3975	7950	11925	15900	19875	23850	15.904	.0688
5	19.635	1964	4910	9820	14730	19640	24550	29460	19.635	.0850
5 1/2	23.758	2376	5940	11880	17820	23760	29700	35640	23.758	.1028

### NOTE:

To determine cylinder pull stroke force or displacement, deduct force or displacement corresponding to rod size in Table 6 from force or displacement corresponding to bore size shown in Table 7.

1 gallon = 231 Cu. In.  
Area of Circle = .7854 d<sup>2</sup>

Piston Speed (In./Min.) =

Pressure Source Delivery (GPM)  
Cylinder Displacement (Gal./In.)

### PIPING:

All pipes should be free from dirt, scale, rust, and threads de-burred. Seamless steel tubing makes an installation superior to piping as it is cleaner and leakproof.

**TABLE 7 — THRUST FORCE AND DISPLACEMENT**

Bore Size	Piston Area Sq. In.	CYLINDER THRUST FORCE IN POUNDS FOR VARIOUS LINE PRESSURES							DISPLACEMENT Per Inch of Stroke	
		100	250	500	750	1000	1250	1500	Cu. Inch	Gallons
1 1/2	1.767	177	442	884	1325	1767	2209	2650	1.767	.00765
2	3.142	314	785	1571	2357	3142	3928	4713	3.142	.0136
2 1/2	4.909	491	1227	2455	3682	4909	6137	7364	4.909	.0213
3 1/4	8.296	830	2075	4148	6222	8296	10370	12444	8.296	.0359
4	12.566	1257	3142	6283	9425	12566	15708	18849	12.566	.0544
5	19.635	1964	4910	9818	14726	19635	24544	29452	19.365	.0850
6	28.274	2827	7067	14137	21206	28274	35342	42411	28.274	.1224

**TABLE 8 — L.H. SERIES PRESSURE RATING**

Bore Dia.	1 1/2	2	2 1/2	3 1/4	4	5	6
Pressure Rating	1500	1500	1500*	1500	1000	1000*	750

\*NOTE: 2 1/2" Bore, 5/8" Rod, Rating 1000 PSI  
5" Bore, 1" Rod, Rating 750 PSI



# Installation and Maintenance Notes

## STORAGE

Often times cylinders are delivered before a customer is prepared to install them and must be stored for a period of time. When storage is required the following procedure should be employed:

1. Select an area indoors for storage, which has a dry and non-corrosive atmosphere. Take caution to protect the cylinder from both internal and external corrosion.
2. Cylinders to be stored should be kept in a verticle position (piston rod up) whenever possible.
3. Port protector plugs should be kept in the cylinder ports until the time of installation.

## INSTALLATION

### General Information

1. Cleanliness—the most important consideration when installing the cylinder. When cylinders are shipped from Milwaukee the ports are securely plugged with plastic plugs, which should not be removed until the piping is to be installed. All piping should be thoroughly clean to include the removal of all threading and flaring burrs or chips before making the connection to the cylinder ports. One chip can cause premature failure of the cylinder or other hydraulic system components.
2. Alignment. Improper alignment will result in excessive cylinder wear. Check to assure rod alignment between the cylinder and its mating component on your machine in both the extended and retracted positions.
3. Environment. Cylinders operating in areas where there is weld splatter, fast drying chemicals, paint, excessive heat or other hazardous conditions, should have covers or shields to prevent damage to the rod and rod seals.

### Mounting Recommendations

1. Foot Mounted Cylinders.  
The use of high strength alloy steel mounting bolts 1/16" smaller than the hole size is recommended. After final alignment foot mounted cylinders should be dowel pinned in place.
2. Trunnion Mounted Cylinders.  
Lubricated pillow blocks, designed for close tolerance applications should be used. It is important to rigidly mount and align the pillow blocks so that the trunnion pins will not be subjected to any extreme bending moments. The rod end should be pivoted with the pivot pin in line and parallel to the axis of the trunnion pins.
3. Flush Mount Cylinders.  
The use of high strength alloy steel mounting bolts is recommended. Shear keys should be used to reduce the stress on the mounting bolts created by the normal push and pull forces created by the cylinder cycle.
4. Flange Mount Cylinders.  
The controlled diameter rod bushing extension can be used as a pilot to locate the flange mount. Dowel pins should be used after the cylinder is mounted and aligned to prevent shifting.
5. Clevis Mount Cylinders.  
This type of cylinder must be pivoted at both ends and the pins must be in line and parallel to each other. After the cylinder is mounted the customer should check to assure that the cylinder is free to swing through its working arc without interference from other machined parts.

## CYLINDER TROUBLE SHOOTING

1. External leakage —  
If leakage occurs between the end cap and barrel check the tie rod torque. If the torque is correct then replace the barrel seal. When leakage occurs in the rod bushing area the rod seals should be replaced. If leakage continues or reoccurs in short period of operation check items 2 thru 5.
2. Cylinder misalignment —  
Side load is a common problem which occurs when the cylinder application does not allow the piston rod to work in line during the extend and retract motions of the cylinder. Evidence of this is excessive seal failure, bushing wear, or galling of the piston rod. Often bending of the piston rod or complete failure (breakage) of the rod occurs.
3. Contamination on the piston rod —  
Dirt and other material is often picked up when the piston rod is extended. When the rod is retracted in an excessively dirty application it often carries the dirt back into the rod seal cavity of the cylinder causing damage to the seals. With a

slight modification of the cylinder rod end, a rod boot can be added to protect the rod bushing and seals for most applications.

4. Bad mountings —  
Due to wear of pivot pins or mounting bolts working loose a cylinder may have side load even though the rod was in line when the cylinder was first installed. All cylinder mountings should be checked periodically.
5. Damaged piston rod —  
An extended piston rod can be damaged by the impact of a hard object which could burr the rod. If this occurs the rod should be checked immediately to prevent seal damage.
6. Internal leakage —  
Inside the cylinder leakage past the piston seals can cause sluggish movement or settling of the cylinder under load conditions. This occurs due to leakage of worn piston seals or rings.
7. Creeping cylinder —  
When a cylinder is stopped in midstroke and it creeps check for internal leakage. Creeping can also be caused by a worn control valve and this should be checked even if the cylinder is found to have internal leakage.

## CYLINDER MAINTENANCE

### Rod Seal Replacement

When changing rod seals extend the piston rod 3" or more if possible being sure to support the rod at all times. Remove the retainer plate screws (if tie rod nuts have to be removed refer to the nut torque specification on this page when re-assembling the cylinder), retainer plate and outer bushing. Using an eye hook or thin screwdriver pry the vees from the end cap cavity (if low pressure air is applied to the rod end port this will help to force the vees from the cavity). The new set of vees should be assembled into the cavity separately and lubed with the soft vee in the center. Replace the rod wiper in the bushing and reassemble the cylinder.

### Piston Seal Replacement

When changing piston seals extend the piston rod 3" or more, if possible, being sure to support the piston rod and the piston at all times. \*Remove the tie rod nuts, blind end cap, the barrel and then the piston seals. A light grease, compatible with the system fluid, should be used on the rings and block vee seals for smooth assembly. Install the block vee piston seals, scarf cutting only the back-up washers. Then install the wear ring. To reassemble start the piston into the tube. When the piston block vee seal is to the edge of the barrel, use a thin rounded blade to start the lip of the block vee, making sure the entire lip is started before moving the piston further into the tube.

\*Note:

When a cylinder has been disassembled this far the barrel seals should at least be inspected if not replaced.

### Barrel Seal Replacement

When replacing barrel seals use the same method of disassembling the cylinder as used when replacing piston seals. The barrel seal O-ring is layed into the groove provided on the inside diameter at either end of the barrel. The inside diameter of the tube groove on the end caps must be checked for nicks or burrs and then greased. Position the end caps squarely on the tube (check to make sure port location is correct) and firmly force or tap the end cap over the tube until it bottoms. Check to make sure the O-ring did not shear and then finish assembling the cylinder.

### Nut Torque Specifications

When it is necessary to remove the tie rod nuts on a cylinder they must be reassembled to the torque specification given below. To prevent the tie rods from twisting when tightened use a vice grips or locking clamp. Note that the torque specification is based on lubricated threads.

#### NUT TORQUE SPECIFICATIONS

Cylinder Bore	1½	2-2½	3¼-4	5-6
TORQUE				
FT. LBS.	8	18	35	60



# Fluids and Seals

## FLUIDS

Hydraulic fluid is much more than the theoretician's incompressible medium. It heats, cools, lubricates and sometimes corrodes mechanical components, picks up and releases gases, and sweeps sludge into supposedly free clearances. The fluid is just as important as any other part of the hydraulic system. In fact, a major portion of hydraulic problems stem from the use of improper types of fluids or fluids containing dirt and other contaminants.

To understand the fluids used in today's industry, you have to divide them into two general areas: petroleum fluids and fire resistant fluids. These in turn break down into a number of different types with different properties. Not all fluids are compatible with the standard seal combinations offered by cylinder manufacturers.

In the chart below is a small sample of the fluids available and the seals with which they are compatible. Specific information on seal compatibility is available from either the fluid supplier or the component manufacturer.

## SEALS

### Buna N Seal

This type of seal is excellent with petroleum products. The seal is rated for a temperature range from -65°F to +250°F, but when used for low temperatures, it is necessary to sacrifice some low temperature resistance. It is a superior material for compression set, cold flow, tear and abrasion resistance.

**This seal is generally recommended for:**

- Petroleum • Water • Water-Glycol

### Polyurethane Seal

The polyurethane seal provides excellent mechanical and physical properties. Recommend for hydraulic service in petroleum based oils where resistance to extrusion and abrasion is required. Temperature range is -40°F to 180°F.

### Ethylene Propylene

This seal is excellent when used with Skydrol 500 and Phosphate Ester Fluids. The seal is rated for a temperature range from -65°F to +350°F.

**This seal is generally recommended for:**

- Phosphate Ester • Steam (to 400°F) • Water • Ketones

### Viton Seal

Viton seals are compatible with a wide range of fluids. This seal is rated for a temperature range from -20°F to +350°F.

**This seal is generally recommended for:**

- Petroleum • Silicate Ester • Diester • Halogenated Hydrocarbons • Most Phosphate Esters

**SEAL COMPATIBILITY WITH COMMON FLUIDS**

Fluid Name	Military Specification	Mfg. No.	Trade Name/Number	Buna N	Polyurethane	EP	Viton Fluorocarbon
Water Glycol	MIL-H22072	1	Houghto-Safe 600 Series	R	U	R	S
		1	Houghto-Safe 500 Series	R	U	R	—
		1	Houghto-Safe 271 Series	R	U	R	S
		4	Ucon Hydrolube	R	U	R	R
		5	Cellugard	R	U	R	R
Water Oil/Emulsion		1	Houghto-Safe 5040	R	U	U	R
		3	Gulf FR	R	R	U	R
Water Soluble Oil		—	—	R	—	R	—
Water Fresh		—	—	R	U	R	S
Water Salt		—	—	R	U	R	S
Phosphate Ester	MIL-19547B	1	Houghto-Safe 1000 Series	U	—	R	R
		1	Houghto-Safe 1120	U	U	R	R
		8	Pyrogard 42, 43, 53, 55	U	U	R	R
		2	Skydrol 500 Type 2	U	U	R	U
		2	Skydrol 7000 Type 2	U	U	R	S
Diester	MIL-H-7808	—	Lube Oil Aircraft	S	U	U	R
Silicate Ester	MIL-H-8446B	7	Brayco 846	S	R	U	R
Kerosene		—	—	R	R	U	R
Jet Fuel	MIL-J-5624	—	JP-3,4,5 (RP-1)	R	S	U	R
Diesel Fuel		—	—	R	M	U	R
Gasoline		—	—	R	S	U	R
Petroleum Base	MIL-H-6083	—	Preservative Oil	R	R	U	R
	MIL-H-5606	—	Aircraft Hyd. Fluid	R	S	U	R
High Water Base 95-5		1	Hydrolubic 120-B	S	R	S	S

### Manufacturer No:

1. E. F. Houghton
2. Monsanto
3. Gulf
4. Union Carbide & Chemical
5. Stauffer Chemical
6. Standard Oil (Ortho Chemical)
7. Bray Oil — Royal Lubricant
8. Mobil Oil

### Seal Compatibility

- R = recommended  
S = satisfactory  
M = marginal  
U = unsatisfactory  
— = insufficient data

### Note:

The above chart is for general information and should not be taken as warranty or representation for which legal responsibility is assumed. The information on this page is offered only for your convenience, consideration, investigation, and verification.

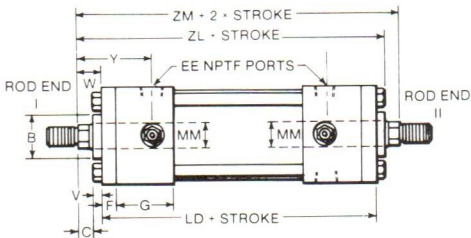
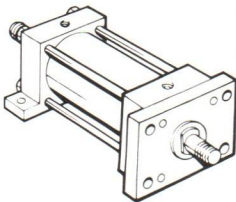


DOUBLE ROD END CYLINDERS

Milwaukee's double rod end cylinders are available with all the standard types of mountings except 61 and 62. When specified by the customer, the standard mountings offered by Milwaukee Cylinder may be combined. Combinations such as a 31 mounting on one end and a 42 mounting on the other can be readily made from standard parts.

To obtain dimensioning information on a double rod end cylinder, first select the desired mounting style and refer to the corresponding single rod end cylinder model shown on the preceding pages. After you have determined all necessary dimensions from the previous page covering the desired mounting, turn back to this page. Supplement those dimensions with additional ones from the drawings below and the table at the right. These added dimensions differ from, or are in addition to, those shown on the preceding pages and provide the additional information needed to completely dimension a double rod end cylinder model.

On a double rod end cylinder where two different rod ends are required or two different rod sizes are required or cushions on one end are required, be sure to state clearly which rod is to go at which end of the cylinder. When two types of mounting styles are required be sure to specify their relationship to the piston rods if they are not the same.



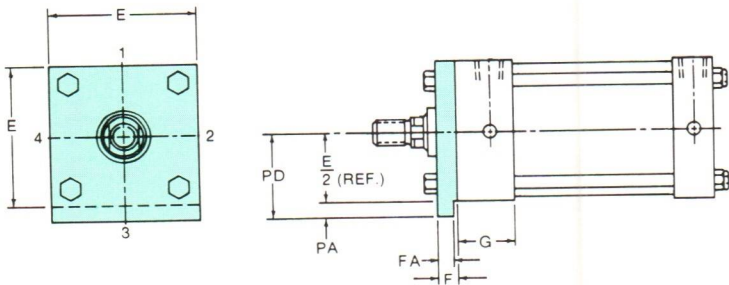
BORE DIA.	ROD MM	CYLINDER CODE*	LD*	SE,*	SS,*	XE,*	ZE,*	ZL	ZM	ZT,*
1 1/2	5/8	D51	4 7/8	6 3/8	3 3/8	6 1/2	6 1/2	5 7/8	6 1/8	6 5/8
	1	D52				6 7/8	6 7/8	6 1/4	6 7/8	6 7/8
2	5/8	D510	4 7/8	6 3/4	3 3/8	6 7/16	6 3/4	5 15/16	6 1/8	6 5/8
	1	D511				6 13/16	7 1/8	6 5/16	6 7/8	7
	1 3/8	D512				7 1/16	7 3/8	6 9/16	7 3/8	7 1/4
2 1/2	5/8	D520	5	7 1/8	3 1/2	6 1 1/16	7	6 1/16	6 1/4	5 3/4
	1	D521				7 1/16	7 3/8	6 7/16	7	7 1/8
	1 3/8	D522				7 5/16	7 3/8	6 1 1/16	7 1/2	7 3/4
	1 3/4	D523				7 9/16	7 7/8	6 15/16	8	7 5/8
3 3/4	1	D530	6	7 3/4	3 3/4	7 5/8	8	7 1/4	7 1/2	8 1/8
	1 3/8	D531				7 7/8	8 1/4	7 1/2	8	8 3/8
	1 3/4	D532				8 1/8	8 1/2	7 3/4	8 1/2	8 5/8
	2	D533				8 1/4	8 5/8	7 7/8	8 3/4	8 3/4
4	1	D540	6	8	3 3/4	7 3/4	8 1/8	7 1/4	7 1/2	8 1/8
	1 3/8	D541				8	8 3/8	7 1/2	8	8 3/8
	1 3/4	D542				8 1/4	8 5/8	7 3/4	8 1/2	8 5/8
	2	D543				8 3/8	8 3/4	7 7/8	8 3/4	8 3/4
	2 1/2	D544				8 5/8	9	8 1/8	9 3/4	9
5	1	D550	6 1/4	8 3/8	3 5/8	8 1/16	8 9/16	7 9/16	7 3/4	8 13/16
	1 3/8	D551				8 5/16	8 13/16	7 13/16	8 1/4	9 1/16
	1 3/4	D552				8 9/16	9 1/16	8 1/16	8 3/4	9 5/16
	2	D553				8 11/16	9 3/16	8 3/16	9	9 1/16
	2 1/2	D554				8 15/16	9 7/16	8 7/16	9 1/2	9 1 1/16
	3	D555								
6	3 1/2	D556	7	8 7/8	4 1/8	9 1/2	10	9 1/16	10	10 5/16
	1 3/8	D560				8 7/8	9 3/8	8 7/16	8 3/4	9 1 1/16
	1 3/4	D561				9 1/8	9 5/8	8 1 1/16	9 1/4	9 15/16
	2	D562				9 3/4	9 3/4	8 13/16	9 1/2	10 1/16
	2 1/2	D563				9 1/2	10	9 1/16	10	10 5/16
	3	D564								
	3 1/2	D565				9 1/2	10	9 1/16	10	10 5/16
	4	D566								

\*Note:  
These dimensions are to be substituted for the related mounting dimensions given on the preceding pages. All dimensions given on this table are plus stroke.

KEY MOUNT CYLINDERS

The Milwaukee Key Mount retainer plate is a mounting option designed to add rugged stability to foot and side mount cylinders. The retainer plate is extended below

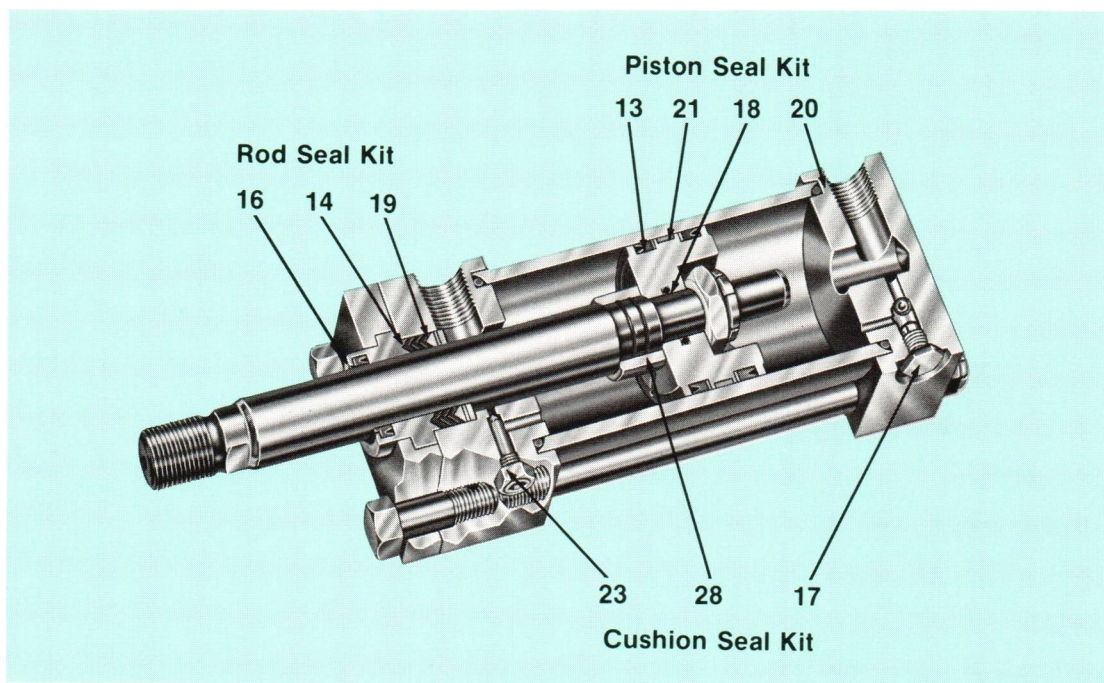
the mounting surface of the cylinder. This extension may be fitted into a milled keyway in your mounting pad, eliminating the need for welded keys or locator pins.



BORE DIA.	E	F	FA	G	PA	PD
1 1/2	2	3/8	.312/.310	1 1/2	3/16	1 3/16
2	2 1/2	3/8	.312/.310	1 1/2	3/16	1 7/16
2 1/2	3	3/8	.312/.310	1 1/2	3/16	1 11/16
3 1/4	3 3/4	5/8	.562/.560	1 3/4	5/16	2 3/16
4	4 1/2	5/8	.562/.560	1 3/4	5/16	2 9/16
5	5 1/2	5/8	.562/.560	1 3/4	5/16	3 1/16
6	6 1/2	3/4	.687/.684	2	3/8	3 5/8



# Seal Kits



## How to Order Complete Seal Kits

When ordering complete seal kits specify the following information on your order:

1. The serial number of the cylinder the seals will be used on.
2. The bore and rod size.
3. If the cylinder is cushioned.

To eliminate untimely delays in the handling of your order please use the seal kit code as shown in the example below.

Example:

Buna-N Kit No. XXXXX-0-40  
-cylinder code number  
(refer to page 6-13)

Viton Kit No. XXXXX-1-40  
-cylinder code number  
(refer to page 6-13)

## How to Order Partial Seal Kits

Refer to the picture above to determine which partial seal kit you require and then select the appropriate kit number from the

tables below. Standard Series "LH" cylinders contain Buna-N seals. Viton seals are used in applications where temperatures are in excess of +250 degrees F.

STD. ROD DIA.	ROD SEAL KIT	
	BUNA-N	VITON
5/8	00151-0-41	00151-1-41
1	00152-0-41	00152-1-41
1 1/8	01511-0-41	01511-1-41
1 3/4	01522-0-41	01522-1-41
2	01532-0-41	01532-1-41
2 1/2	01542-0-41	01542-1-41
3	01552-0-41	01552-1-41
3 1/2	01553-0-41	01553-1-41
4	01563-0-41	01563-1-41

BORE SIZE	PISTON SEAL KIT	
	BUNA-N	VITON
1 1/2"	00051-0-43	00051-1-43
1 1/2"	00051-0-42	00051-1-42
2"	00510-0-43	00510-1-43
2"	00510-0-42	00510-1-42
2 1/2"	00520-0-43	00520-1-43
2 1/2"	00520-0-42	00520-1-42
3 1/4	00530-0-42	00530-1-42
4	00540-0-42	00540-1-42
5	00550-0-42	00550-1-42
6	00560-0-42	00560-1-42

BORE SIZE	ROD SIZE	CUSHION SEAL KIT	
		BUNA-N	VITON
1 1/2 THRU 2 1/2	5/8	00011-0-51	00011-1-51
	1	00012-0-51	00012-1-51
	1 3/8	00112-0-51	00112-1-51
	1 3/4	00123-0-51	00123-1-51
3 1/4 THRU 5	1	00130-0-51	00130-1-51
	1 3/8	00131-0-51	00131-1-51
	1 3/4	00132-0-51	00132-1-51
	2	00133-0-51	00133-1-51
	2 1/2	00144-0-51	00144-1-51
	3	00155-0-51	00155-1-51
6	3 1/2	00156-0-51	00156-1-51
	1 3/8	00160-0-51	00160-1-51
	1 3/4	00161-0-51	00161-1-51
	2	00162-0-51	00162-1-51
	2 1/2	00163-0-51	00163-1-51
	3	00164-0-51	00164-1-51
	3 1/2	00165-0-51	00165-1-51
	4	00166-0-51	00166-1-51

\*For cushioned cylinders with 5/8" piston rod only.



## How to Order

### Series "LH" Cylinders

Standard Series "LH" Cylinders can be completely and accurately described by a model number consisting of coded symbols. If your requirements are completely standard, select the symbols from page 23 that represent your cylinder and place them in the sequence indicated by the example. Use of the cylinder code will eliminate untimely delays in handling your order. Be sure to include with your order, all of the information requested in the applications data area.

General Order Data (Covered by the cylinder code)

1. Bore & Rod size or the cylinder code: (refer to page 6-13)
2. Mounting Style: (refer to page 6-13)
3. Rod End Style: (refer to page 2)
4. Cushion Requirements
5. Length of Stroke

Note: Duplicate cylinders can be ordered by giving the serial number from the nameplate of the original cylinder. Factory records supply a quick, positive identification.

### Replacement Seals or Cylinder Parts

For replacement seals or cylinder parts, the serial number of your cylinder, the cylinder code number and the item number of the part you require (page 23) should appear on your order. To order entire seal kits for your cylinder refer to page 21.

### Applications Data

1. Port Requirements: refer to page 15.
2. Operating Fluid or Medium: Series "LH" cylinders are equipped with seals for use with hydraulic oil. If other than a quality grade hydraulic oil will be used specify the type of fluid in your order.
3. Temperature Range: Series "LH" hydraulic cylinders contain seals of Nitrile (Buna-N) suitable to -30 degrees F to +250 degrees F. Specify your operating temperature if your application does not fall within this temperature range.
4. Operating Pressure: Series "LH" cylinders are rated for 1500 PSI to 750. If your requirements are in excess of the rated pressure describe your application in your order. (Ref. page 17 — Table 8.)
5. Accessories: Specify any accessories you require using the part numbers given on page 23.
6. Special Requirements: If you require special seals, rod materials, stop tube, center support, adjustable stroke, or any other special requirements not covered, specify in detail on your order.

## Retainer Plate Capscrew Torques

Retainer Plate  
Capscrew Torques  
All Rod Sizes —  
Models LH21 and LH31

BORE	TORQUE (LBS.-FT.)
1 1/2	5
2	12
2 1/2	12
3 1/4	30
4	30
5	50
6	50

Retainer Plate Capscrew Torques  
Models LH22, LH32,  
LH61 and LH73

BORE	ROD	TORQUE (LBS.-FT.)
1 1/2	5/8	6
2	5/8	6
	1	15
2 1/2	5/8	6
	1	15
	1 3/8	15
3 1/4	1	15
	1 3/8	15
	1 3/4	15
4	1	15
	1 3/8	15
	1 3/4	15
	2	15
5	1	15
	1 3/8	15
	1 3/4	15
	2	15
	2 1/2	27
	3	27
6	1 3/8	15
	1 3/4	15
	2	15
	2 1/2	27
	3	27
	3 1/2	27
	4	27

## WARRANTY

Seller warrants the goods sold hereunder to be free from defects in material and workmanship for a period of twelve months after date of shipment from Seller's plant. If the goods are in accordance with or in reference to an engineering drawing specified by or furnished to the customer, the specifications and information on the drawing shall be applicable in determining such correct use, operation and application.

When claiming a breach of the above warranty, Buyers must notify Sellers promptly in writing whereupon Seller will either examine the goods at their site, or issue shipping instructions for return to Seller.

When any goods sold hereunder are proved not as warranted, Seller's sole obligation under this warranty shall be to repair or replace the goods, not including installation

or any other charges, at its option, without charge to Buyer.

THIS WARRANTY COMPRISES SELLER'S SOLE AND ENTIRE WARRANTY OBLIGATION AND LIABILITY TO BUYER, IT'S CUSTOMERS AND ASSIGNS IN CONNECTION WITH GOODS SOLD HEREUNDER. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS ARE EXPRESSLY EXCLUDED.

CONSEQUENTIAL DAMAGES: In no event shall Seller be liable for consequential or special damages arising out of a delay in or failure of delivery, defects in material or workmanship, or arising out of a breach by Seller of any other term or obligation of Seller under this contract.



# Cylinder Force and Speed

## Hydraulic Cylinder Force

Table 7 on page 17 shows the thrust force developed by various bore diameters when working at various pressures. These figures do not include a factor covering a reduction in force due to seal or packing friction in the cylinder. This type of friction is estimated to affect the cylinder thrust force by 10%. Additional pressure must be developed by the pump not only to overcome frictional loss, but also flow losses in the circuitry. The engineer should realize that the useable pressure in the cylinder may be from 10% to 25% less than the pump and relief valve gauge reading.

## Hydraulic Cylinder Speed

Figures shown in the body of this chart are cylinder rod travel speeds in inches per minute. The extension speeds represent the net piston area for the various rod diameters shown.

HYDRAULIC CYLINDER SPEEDS

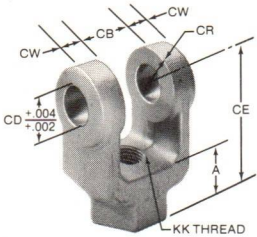
Piston Dia.	Rod Dia.	1 GPM	3 GPM	5 GPM	8 GPM	12 GPM	15 GPM	20 GPM	25 GPM	30 GPM	40 GPM	50 GPM	75 GPM
1½	None	130	392	654	1034								
	5/8	158	476	792	1265								
	1	235	706	1176	1880								
2	None	73	221	368	588	883	1120						
	1	97	294	490	782	1175	1465						
	1½	139	418	697	1115	1673	2090						
2½	None	47	131	235	376	565	675	940	1175				
	1	56	168	280	448	672	840	1120	1400				
	1½	67	203	339	542	813	1015	1355	1695				
3¼	None	28	83	139	223	334	417	557	696	836	1115		
	1½	34	102	170	271	407	510	680	850	1020	1360		
	2	44	134	224	358	537	672	896	1120	1344	1792		
4	None	18	55	92	147	220	276	368	460	552	736	920	
	1½	22	68	113	182	273	339	452	565	678	904	1130	
	2	24	73	122	196	294	366	488	610	732	976	1220	
5	None	12	35	58	94	141	174	232	290	348	464	580	870
	2	14	42	70	112	168	210	280	350	420	560	700	1050
	2½	16	47	78	125	188	235	315	390	470	630	780	1170
6	None	8	24	41	65	98	123	162	202	245	320	405	606
	2½	10	30	50	79	118	150	200	250	300	400	495	750
	3	11	33	54	87	130	165	206	270	325	435	545	810
7	None	6	18	30	48	72	90	120	150	180	240	300	450
	3	7	22	37	59	88	110	145	185	220	295	365	555
	3½	8	24	40	64	96	120	160	200	240	320	400	600
8	None	4	14	23	36	55	69	92	115	135	185	230	345
	3½	5½	17	28	45	68	85	115	140	170	230	285	420
	4	6	18	30	49	73	90	122	150	180	240	305	450
10	None	3	9	15	23	35	44	60	73	88	115	145	220
	4½	3½	11	18	29	44	55	75	92	111	150	185	275
	5	4	12	20	31	47	60	80	100	120	155	195	300
	5½	4½	13	21	34	50	63	84	105	132	165	210	315
	7	5½	17	29	46	69	87	115	145	174	230	285	435



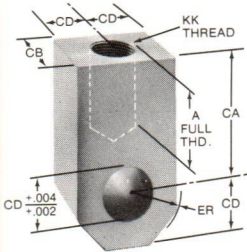
Dimensional data

CAUTION

The accessories are rated for load capacities equal to the standard load capacity of the related cylinder bores given on this page only when standard rod sizes are used. For special applications information consult with your local Milwaukee representative or contact the factory.



ROD CLEVIS

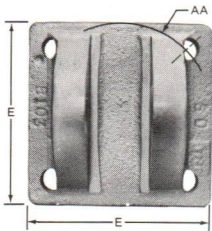
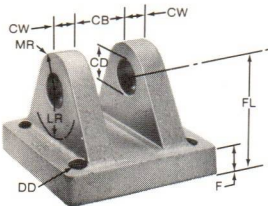


ROD EYE

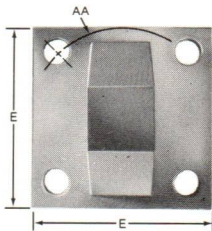
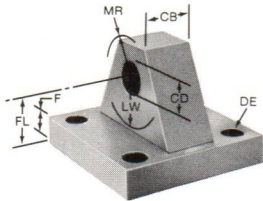
Note:

The rod clevis and rod eyes are designed for use with the standard "Milwaukee" style No. 2 rod end. When ordering these accessories be sure to match the thread size of the style No. 2 rod end of the rod size you ordered to the thread size of the accessory you require.

ROD CLEVIS		ROD EYE		MAX. LOAD (TENSION) POUNDS	THD. SIZE	A	CA	CB	CD	CE	CR	CW	ER
PART NO.	CODE	PART NO.	CODE		KK								
15-72-1001	C101	15-73-1001	C301	4380	7/16-20	3/4	1 1/2	3/4	1/2	1 1/2	1/2	1/2	9/16
15-72-1002	C102	15-73-1002	C302	12372	3/4-16	1 1/8	2 1/16	1 1/4	3/4	2 3/8	3/4	5/8	15/16
15-72-1003	C103	15-73-1003	C303	20433	1-14	1 5/8	2 13/16	1 1/2	1	3 1/8	1	3/4	1 1/8



CLEVIS BRACKET



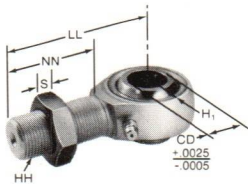
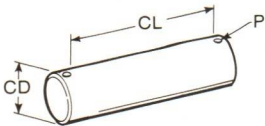
EYE BRACKET

CLEVIS BRACKET		EYE BRACKET		MAX. LOAD (TENSION) POUNDS	AA	CB	CD	CW	THD. SIZE	DE	E	F	FL	LR	LW	MR
PART NO.	CODE	PART NO.	CODE						DD							
15-74-2001	B101	15-75-2001	B401	7510	2.3	3/4	1/2	1/2	3/8-24	13/32	2 1/2	3/8	1 1/8	1 3/16	1 1/16	1/2
15-74-2003	B102	15-75-2003	B402	20082	3.6	1 1/4	3/4	5/8	1/2-20	17/32	3 1/2	5/8	1 7/8	1 5/16	1 1/8	3/4
15-74-2004	B103	15-75-2004	B403	27684	4.6	1 1/2	1	3/4	5/8-18	2 1/32	4 1/2	3/4	2 1/4	1 3/8	1 1/4	1

PIVOT PIN				
PART NO.	CODE	CD	CL	P
15-76-1001	P101	1/2	1 7/8	9/64
15-76-1002	P102	3/4	2 5/8	9/64
15-76-1003	P103	1	3 1/8	13/64

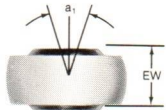
PIVOT PIN

- 1) Pivot pins are furnished with clevis mounted (A-61) cylinders as standard.
- 2) Pivot pins for 1 1/2"-6" bore are furnished with cotter pins.
- 3) Pivot pins are not furnished as standard and must be ordered separately for use with accessories.



SPHERICAL ROD EYE

Note:



The spherical rod eye is used with Style 3 and 5 rod ends.

PART NO.	MAX. LOAD (TENSION) POUNDS	SPHERICAL ROD EYE							
		a <sub>1</sub>	CD	EW	H <sub>1</sub>	HH	LL	NN	S
S-301	1450	12°	1/2	5/8	1 1/16	7/16-20	2 7/16	1 5/32	1/4
S-302	2880	13 1/2°	3/4	7/8	29/32	3/4-16	2 27/32	1 23/32	7/16
S-303	10885	14°	1	1 3/8	1 13/32	1-14	4 3/32	2 3/32	9/16



# Cylinder Order Code — Model Number

FEATURE	DESCRIPTION	PAGE NO.	CODE NO.	EXAMPLE
DOUBLE ROD END		20	D	
CYLINDER CODE	REFER TABLE 1	7, 9, 11 & 13	—	
MOUNTING STYLE	MODEL NUMBER ONLY	6, 8, 10 & 12	—	
ROD END STYLE	CODE NUMBER	2	—	
CUSHIONS	NONE ROD END BLIND END BOTH ENDS	— — — —	1 2 3 4	
CYLINDER MODIFICATIONS	SPECIAL		S	
SEALS	BUNA (-30° TO 250° F) VITON (-15° TO 350° F) SPECIAL		1 2 S	
STROKE	SPECIFY IN INCHES INCLUDING FRACTIONAL REQUIREMENTS		—	

**\*NOTE:**  
USE "S" IF ANY SPECIAL DESIGN FEATURES OR SEALS ARE REQUIRED. DESCRIBE IN DETAIL ON YOUR ORDER.

**EXAMPLE: THE CODE FOR A SERIES LH-31 CYLINDER 4" BORE, 1-3/4" ROD, STYLE NO. 1 ROD END, CUSHION BOTH ENDS STANDARD SEALS WITH A 14 3/4" STROKE IS-542-31-14-1 x 14 3/4".**

Standard Parts List		ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
		1	PISTON ROD	17	O-RING SEAL FOR BALL CHECK RETAINER
		2	CYLINDER BARREL	18	O-RING SEAL FOR PISTON
		3	HEAD END CAP	19	WAVE SPRING
		4	CAP END CAP	20	CYLINDER BARREL O-RING
		5	ROD BUSHING	21	WEAR RING
		6	RETAINER PLATE	22	TIE ROD FLEX LOC NUT
		7	PISTON	23	TEFLON RING SEAL FOR CUSHION ADJ. NEEDLE
		8	CUSHION PLUNGER	24	PISTON NUT
		9	CUSHION ADJ. NEEDLE	25	JAM NUT FOR CUSHION ADJ. NEEDLE
		10	BALL CHECK RETAINER	26	TIE ROD
		11	BALL CHECK	27	NYLOCK CAP SCREW
		12	N/A	28	O-RING FOR FLOATING CUSHION
		13	BLOCK VEE PACKING		
		14	ROD VEE RING SET		
		15	PACKING WASHER		
		16	ROD WIPER		



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